#21379601
ID88019088

QL
666
.C584
K374
1979

AN ECOLOGICAL STUDY OF A POPULATION OF DESERT TORTOISES, *GOPHERUS AGASSIZI*, IN SOUTHERN NEVADA

~~Piute Valley~~
cresent Peak Allotment

SPRING, 1979

Alice Karl
21126 Chatsworth St.
Chatsworth, California 91311

Contract No. YA-512-CT9-90
Bureau of Land Management
Department of the Interior
Building 5, Denver Federal Center
Denver, Colorado 80225

Bureau of Land Management
Library
Bldg. 50, Denver Federal Center
Denver, CO 80225

QL
6
C584
K374
1979

ABSTRACT

Desert tortoises (Gopherus agassizi) were censused for 30 days during spring, 1979 on a permanent study plot in Clark Co., Nevada.

1) Density was estimated to be 125 to 150 tortoises per square mile.
2) Natality was determined to be low due to the low number of dead and live tortoises under 100 mm maximum carapace length (MCL) found and the sex ratio of 0.68 females : 1 male.
3) Growth was greatest in immature tortoises (the youngest group sampled), 7.1%, 5.8% and 2.5% of the original MCL.
4) Seven adult tortoises were undersized for their degree of shell wear, possibly a result of heredity, grazing pressure and/or decreased daily activity periods due to high Nevadan temperatures.
5) Observations of movement, sensory perception, burrow preference and size associations, eggs and thermoregulatory, feeding, intra- and interspecific behaviors were made.
6) The vegetation of the site was sampled to determine present composition and density.
7) The suggestion is made for future studies of vegetation, population size structure, sex ratio and density in order

to generate conclusive data regarding significant trends and influences on this population. Heavy grazing is suggested as a possible cause for this population's decline.

INTRODUCTION

The Bureau of Land Management (BLM) is required to file a Grazing Environmental Statement for Clark County, Nevada. The desert tortoise, Gopherus agassizi, is being given special attention because of listing as a "sensitive" species by each State Director and Director of State wildlife agency. Data on the desert tortoise was collected in spring, 1979, on two permanent study sites, one of which was in southwestern Clark County. The study was conducted primarily to determine absolute density, age structure and sex ratios and secondarily to examine behaviors. In addition, the vegetation was sampled to determine absolute and relative frequencies, volume and densities for perennial species and absolute frequencies and percent covers for annuals.

Burge (1977a) intensively studied the population dynamics, movements and behaviors of a population of desert tortoises ca 80 km north of this study site. A permanent study site has also been established ca 60 km west in Shadow Valley, California (Karl, 1978) and ca 30 km south in Ivanpah Valley, California (Burge, 1977b; Woodman, 1979). The author also studied a population of desert tortoises ca 35 km northwest in Nevada (Karl, 1979a).

STUDY AREA

Location. The study site is located in Piute Valley, Clark County, Nevada 18.4 km due south of Searchlight and 4.4 km due west of U.S. Highway 95. It comprises Section 34 of T30S and R63E, located on the Searchlight 15' topographical map.

Habitat. The site comprises a valley with an average southeast slope of 1.7% and an average elevation of 2580 ft. (2520 to 2645 ft.). A few wide, but shallow, sandy washes traverse the plot and the northwest corner and western border are replete with narrow, shallow watercourses, several of which extend nearly to the southern border (Appendix 5). Large patches of desert pavement are interspersed between the watercourses along the western border and in the southwest corner. Soft (consistence when dry), coarse sandy loam, littered with fine basaltic gravel (U.S.D.A., 1960) covers the remainder of the plot's surface.

The perennial vegetational community is primarily composed of small Larrea tridentata and Ambrosia dumosa in the eastern two-thirds of the plot, evolving to a Yucca schidigera forest with a moderate degree of shrub diversity, including Acamptopappus sphaerocephalus and Eriogonum fasciculatum, in the west-southwestern one-third (Appendix

XV, Photo Station 2). Perennials are moderately dense in the northeastern quarter, decreasing slightly over the remainder of the plot with the exception of the wash banks and those areas between the patches of desert pavement, where they are very dense. Annuals are dense and moderately diverse, dominated by *Festuca octoflora* and *Chaenactis* spp. and represented by moderate amounts of borages, *Erodium cicutarium* and *Malacothrix glabrata* (Appendix XV, Photo Stations 1, 3, 4 and 5).

Total rainfall during the study was ca 20 mm (this figure taken from the United States Climatological Survey for Las Vegas); light rain occurred on 19 May. Winds issued primarily from the south at an average speed of 3.5 m/sec (0 to 11 m/sec). Average air temperatures were extrapolated from temperatures recorded throughout the day, resulting in average April highs of 26°C and diurnal April lows of 16.2°C, May highs of 35°C and diurnal lows 16.0°C and June diurnal lows of 19.7°C. It was difficult to assess June highs accurately but they were above the May highs.

Human influence. The study site is heavily grazed and there is one water haul (not in use during the study) on the eastern border, another 1.1 km north and a corral with a well 5.4 km north. Several cattle were seen daily grazing on the plot. An infrequently used dirt road (travelled primarily by the ranch employees) extends the length of the plot and beyond near the eastern border and an overgrown jeep trail traverses the northeast quarter.

METHODS AND MATERIALS

Tortoises were sought for 30 days from 16 to 25 April (10 days), 15 to 25 May (11 days) and 5 to 13 June (9 days). Work was performed by one investigator with the exception of five days when a second person assisted. Searching hours were ca: a) 0630 to 1130 hrs (PST) and 1400 to 1830 hrs for April (9.5 hours); b) 0600 to 1100 hrs and 1500 to 1830 hrs for May (8.5 hours); and c) 0500 to 1100 hrs and 1630 to 1700 hrs for June (8.5 hours).

The plot was covered by systematically walking short transects, ca 0.3 km in length and spaced ca 10 m apart (that distance determined by vegetational density). Ultimately they covered a rectangular section of the plot, the width of which was determined by the time allocated to searching each day and the number of tortoises found. (It required ca 20 minutes to examine a new capture.) This method was felt to be most effective because (1) it was unlikely that a tortoise would travel so quickly as to avoid being sighted either on the forward or return transect;

the short transect length encouraged rapid return by the researcher; and (2) it enabled the researcher to view an area from various angles. To avoid duplicate searching, the daily area covered was mapped. Flagging of tall perennials every 0.2 miles and the mapping of landmarks, plus an aerial photograph and a topographical map assisted in the accuracy of determining locations. The plot was covered ca 1.3 times in the 30-day period.

Upon discovery of a tortoise, it was initially observed without disturbance, when possible, to determine behavior. Subsequently, several measurements were taken and recorded on forms provided by the B.L.M. (Appendix VI). The first measurement taken (in an effort to obtain an accurate measurement prior to voiding) was the weight of the individual, determined by supporting the tortoise in a nylon net attached to a Chatillion scale. If the animal voided, an attempt was made to capture the urine. The amount, color, viscosity and presence of insolubilities were noted. In addition to weighing the tortoise, the following measurements were taken, using Brown and Sharpe calipers: maximum carapace length (MCL), width at marginals 3 (posterior), 4 (mid), and 7-8 (seam), greatest width and its location, height at mid central 3, plastron length from notch to notch (PL N) and maximum plastron length (PL T). Care was taken to leave the tortoise on its carapace for minimal periods as its breathing appeared to be labored in this position and because the chance of causing torsional problems (intestinal twisting) was decreased (Berry, personal communication). Evidence of parasites or new growth was noted and the growth rings were counted. In addition, the sex was noted (for individuals over ca 180 mm MCL) and the gular condition and shell wear, were described and drawn. Injuries and anomalies were described, drawn and photographed. Photographs were also taken of the carapace, plastron and left costals 3 and 4. Behaviors, before, during and after handling, were recorded. Temperatures were taken with a Schultheis termometer, the bulb of which was manually shaded, one meter above the ground (T_a), one centimeter above the ground (T_{1cm}) and on the ground surface (T_{gs}). Cloud cover, wind direction and wind speed (the latter using the Beaufort technique) were recorded. The location of the tortoise was noted and mapped (Appendix I). Finally, each tortoise was consecutively numbered by notching in accordance with the Desert Tortoise Council notching system (Appendix VII), always notching at least two marginals (thus skipping single number marginals such as 1 through 10, 20, 30, etc.). In addition, the number was painted on a rear marginal with yellow acrylic paint to allow the investigator to identify an unobtainable tortoise in a burrow. (Tortoises were initially painted on an anterior marginal also, but I felt that this increased their visibility to predators and was generally unnecessary as most tortoises are found head-in in burrows.)

After releasing a tortoise, the immediate vicinity within a radius of 50 m was searched in order to locate the tortoise's burrow or pallet. (This procedure was reversed if a fresh burrow or pallet was located prior to observing a tortoise.) Length of the burrow and two lengths for a pallet, one from the interior end to the edge of the overhang and the second from the overhang edge to the end of the "apron," were measured. Height, width, soil cover, vegetal cover, direction, slope, co-occupants, curvature (determined with the aid of a mirror) and the distance and direction from the tortoise were also recorded, length measurements being taken with a collapsible pole and a tape measure. The burrow or pallet was then mapped (Appendix II) and marked with a rock cairn to aid in identification when observing future use.

Upon recapturing a tortoise, mapping and measuring for weight and MCL were repeated in order to observe changes. If the tortoise was recaptured within a few days, only location and weight were recorded. Additionally, the behavior was observed.

All shells or parts encountered were photographed in situ and collected subsequent to searching the area within several meters of the initial discovery for all remains.

Shells were labeled (number, site, date, principal investigator's name) and, if possible, measured with respect to plastron and carapace lengths, widths at marginals 3, 6 and either marginal 8 or the flare. Sex, possible mortality factors, condition of the skeleton and scutes, and the location of the remains were noted. All data were recorded on forms provided by the B.L.M. (Appendix VIII) and the specific location of the shell was mapped (Appendix III).

Perennial vegetation was sampled along five permanent transect lines through homogeneous vegetal communities following the point-centered quarter technique. (Cottam and Curtis, 1956) on 25 May and 14 June. Tortoises were not actively sought during vegetation analyses but were "processed" if found. Annual vegetation was sampled between the 21st and 25th of both April and May and between the 12th and 13th of June. Twenty samples along each perennial transect line were taken each month using the canopy coverage method (Daubenmire, 1959).

Wind speed and direction, T_a and cloud cover were recorded at the beginning of each day.

All mammalian predators and raptors and their sign were noted; the former was mapped. All predator scat were examined for tortoise remains.

RESULTS

Population and Parameters

Density. Eighty-four tortoises were captured during the thirty-day study, 28 in April, 36 in May and 20 in June. As the plot was covered only ca 1.3 times, a standard mark-recapture calculation (e.g. Lincoln Index; Marten Regression Method, 1970; Hayne modified Lincoln Index, 1949) could not be performed. However, a Schnabel (1938) calculation indicated a population density of ca 130 tortoises per square mile. This might be an underestimate of the population size as recaptures rarely exceeded unmarked captures in each daily census at the close of field work. Tortoise mobility and obscured visibility undoubtedly decrease absolute density from actual density. The population estimate is thus 125 to 150 per square mile.

Age structure and sex ratios. The age structure of this population as expressed in Table I indicates a high proportion of individuals over 100 mm MCL, with adults (>207 mm MCL) and immatures (101 to 179 mm MCL) constituting approximately the same proportion of the population, 38.1 and 35.7%, respectively, subadults (180 to 207 mm MCL) following closely with 21.4%. The percentage of hatchling (no growth rings) and juvenile (≥ one ring, to 100 mm MCL) captures, only 5%, undoubtedly underestimates the actual proportion of the total population occupied by tortoises less than 100 mm MCL. Tortoises of this size are more difficult to sight due to their cryptic coloration, size and "freezing" behavior, and because their burrows are often hidden and often indistinguishable from those of rodents. Although the ratio of subadult and adult females to males of the same age-size categories, 1.2~~7~~2:1.0, appears to favor reproduction, it was the ratio of subadults (which have not necessarily reached reproductive maturity), 5 females : 1 male, which influenced the combined results to favor females. The adult sex ratio was only 0.68 females: 1.0 male. Loss of forage due to cattle grazing may have contributed to the reproductively unfavorable adult sex ratio as the impact of reduced forage is greater on reproducing females than males or immature females (Berry, 1976). Because the breeding success is positively correlated with the quality and quantity of available forage, reduced food availability caused by cattle grazing may have contributed to low reproduction and the consequent low percentage of individuals under 100 mm MCL.

Dispersion. There were greater numbers of tortoises in the southern one-half of the plot and concentrations along the division of the southeastern one-third (Appendix I). Vegetation and soil density in the southern half was

Table I. Live tortoise captures.

Size Class	Sex			Total	%
	Unknown	♀	♂		
Hatchling (no. ring)	1	—	—	1	1.2
Juvenile I (≤1 ring, to 60 mm)	—	—	—	0	0.0
Juvenile II (61-100 mm)	3	—	—	3	3.8
Immature (101-180 mm)	29	—	1	30	35.7
Subadult (181-207 mm)	—	15	3	18	21.4
Adult (> 207 mm)	—	13	19	32	38.1
Totals	33	28	23	84	100

varied. However, tortoises were often found, singly or in groups, on patches of desert pavement, possibly because these bare patches afforded them increased visibility to other tortoises and perhaps because they were bordered by dense and diverse vegetation, providing protective cover and forage. Courtship and copulation were observed here on two occasions. Several short, fresh burrows were found in the wash adjacent to a well-populated section of pavement.

Tortoises were also seen digging in the desert pavement, both to eat soil and to construct drinking pools (several of the latter seen on 20 May after the previous night's rain).

Although the amount of predator sign was slight, it was greatest in the southeastern one-third (Appendix IV).

Mortality. Ten shells, including two small groups of fragments, were found. The highest recovery occurred in tortoises over 180 mm MCL, slightly greater for adults than subadults (Table II). However, when expressed as the percent of live tortoises found in each age-size class, the highest mortality was found to occur in the Juvenile II category (33.3%), second highest in subadults (22.2%) and third highest in adults (15.6%). The result that there were no shells under 60 mm MCL may be due to the lack of ossification in this size tortoise and the resultant rapid deterioration of the shell (Berry, personal communication). However, in a California population of tortoises examined by the author (Karl, 1979b), individuals under 60 mm totaled 18.5% of the deaths, indicating that while deterioration of the skeleton might alter shell recovery results, shells of this size will often be found. Consequently, the lack of discovery of shells of this size is probably indicative of the low proportion of the live population occupied by this size tortoise. The single juvenile II skeleton was a large member of its class, 89 mm MCL, which would support the low percentage of live tortoises under 100 mm MCL.

Table II. Tortoise skeletal remains.

Size Class	Sex Unk.	♀	♂	Total	%
Hatchling	—	—	—	0	0
Juvenile I	—	—	—	0	0
Juvenile II	1	—	—	1	10.0
Immature	—	—	—	0	0
Subadult	—	3	1+	4	40.0
Adult	2+	—	3++	5	50.0
Total	3	3	4	10	100

+ Fragment groups. Sex identification is not absolute.

++ Probable sex and size class reported. One individual was possibly a subadult and one was possibly a female.

The shell wear scheme used to determine approximate age since death, presented by Luckenbach (1976), showed that of the 10 shells, 4 had been present for 6 months to

1 year, 3 for 1 to 2 years, 1 for 1 to 3 years and 2 for 3 to 5 years. This indicated an average yearly mortality for the entire population of 2.2% (of the estimated density) to 4.0% (of the absolute density of tortoises found) and resulted in a yearly mortality of 6.7% for juvenile II's, 4.4% for subadults and 3.1% for adults.

Three dead subadult females and one subadult male were found. No adult females and three probable adult males were found. There were two shells of undetermined sex in the adult class and two of the males were questionable, one as to sex and one as to class. The sex of the subadults was questionable. The small number of skeletal remains recovered precluded determination of a sex ratio.

Seven out of ten shells were broken, possibly indicating crushing by cattle, vehicles or predators (although tooth marks were not evident). One shell was definitely chewed by a predator, although the cause of death was uncertain as the tortoise was large (a subadult) and nearly entire with a few tooth marks on the periphery of the shell. One dead tortoise had been shot and one shell was entire.

What basis? Conjecture

Mammalian predators (other than man) on the site included kit foxes (*Vulpes macrotis*), coyotes (*Canis latrans*) and badgers (*Taxidea taxus*). The former two were evident by the presence of scat, burrow and excavations and the latter by burrows. It is probable that the gray fox (*Urocyon cinereoargenteus*) and bobcat (*Lynx rufus*) were also present as their ranges extend into the area of the study.

The sole raptor sighted on the study plot was a Golden Eagle (*Aquila chrysaetos*). However, Burrowing Owls (*Speotyto cunicularia*) and Barn Owls (*Tyto alba*) were seen in Piute Valley and Searchlight and the ranges of the Great Horned Owl (*Bubo virginianus*), Swainson's Hawk (*Buteo swainsoni*), Red-tailed Hawk (*B. jamaicensis*), Ferruginous Hawk (*B. regalis*) and Prairie Falcon (*Falco mexicanus*) extend to include the study site. Ravens (*Corvus corax*) were also present during the study and have been reported as predators of young tortoises (Woodbury and Hardy, 1948).

Predators influence shell recovery results as they carry shells away from their original locations (Luckenbach, 1976) and dispose of whole small tortoises by devouring them. The number of incomplete shells may attest either to predator influence or collection by woodrats (*Neotoma* sp.) and Ravens (Peterson, 1961).

Several burrows were found with hoofprints through the roof (Appendix XV, Miscellaneous Photos). In addition, whole shrubs were uprooted and trampled accompanied by possible burrow demolition. Thus, cattle not only present a forage availability problem to tortoises, but also present a direct threat by trampling. This is well documented by Berry (1976, 1978).

Ticks were parasitic on 17 tortoises (20.2% of the total population), two of which possessed ticks on their initial capture and again upon recapture. All 17 tortoises were over 134 mm MCL with 58.8% adults, 23.5% subadults and 17.6% immatures. Ticks numbered from one to hundreds per tortoise and were all located on the carapace. None were noticed on the skin. in 84.2% of 19 samples ticks were attached to marginals, in 57.9% were on the posterior carapace, in 47.7% were on the scute seams and in 26.3% were in scute centers. In 15.8% they were attached under the edges of deep chips, under peeling and in chips. Grant (1936), Harbison 1937) and Woodbury and Hardy (1948) noted that ticks attached to shell sutures, exposed bone and soft skin, possibly due to ease of access to the blood supply.

Three tortoises, all adult males, breathed audibly. However, in one of these instances, this occurred after (and possibly due to the exertion of) breeding. No nasal discharges were noticed on any of the tortoises.

Shell Wear. Shell wear comprised shallow chipping, peeling, rubbing and sinking scutes. New growth was evident as a medium-grey flat area between seams, evident initially on the plastral midline and upper marginal seams. On several tortoises there appeared to be numerous tiny bubbles, possibly composed of air, just beneath the surface of the scutes, particularly noticeable on the plastron. Ten tortoises (11.9%) exhibited dry, white peeling as if the shell had been rasped. Shell wear for approximate age-size classes, obtained from a study of 195 tortoises in California (Karl, 1979b) is presented to aid the reader in future research. Data from tortoises on the Piute Valley study site agree with the scheme:

(1) ≤60 mm MCL-Specimens from this group had 0 to 3 growth rings, dark brown eyes and straight scute seam lines. The granular hatchling plate extended over nearly the entire scute, with the exception of the growth rings. The umbilical area was generally wrinkled and pinched-appearing. Plastron scutes were pale yellow-brown and dark brown in the seam areas and along the growth rings, fading to a rich chestnut-brown toward the scute center and ultimately to a pale yellow-orange-brown area, often with a dark spot, in the scute center. The nuchal was recessed from the scalloped anterior marginals and exhibited a pronounced

double notch. The vertebral ridge was evident as a darkened, spotted line. Of four specimens examined for an egg tooth, only one, 49.5 mm in length with one growth ring, possessed a prominent one. One hatchling, producing its first ring at 50.5 mm MCL, and another, at 53 mm MCL with one ring, exhibited only the remnants of an egg tooth. The fourth hatchling examined, at 53.5mm MCL and producing its first ring, possibly possessed a very blunt egg tooth. One hatchling in Nevada with one nearly complete growth ring possibly had a very blunt egg tooth.

(2) 61-180 mm MCL-Tortoises of this size group were basically identified, with regard to age, by size rather than shell wear, the latter comprising the development of scute material to form new, distinct growth rings. The granular hatchling plate was still in evidence, for the most part, and the nuchal extended with age to become flush with the smooth, albeit somewhat pointed, first marginals. The double notch in the nuchal became increasingly indistinct (although retaining its dual character) and the approximately triple pygal notch became reduced and more of a singular nature. The eye color

had lightened, in most cases, to a medium green-gold.

(3) >180 mm MCL-In order to separate age categories for this size tortoise, it was appropriate to rely more on the following progression of shell wear than on carapace length (although a definite correlation existed between size and shell wear, with some exceptions):

(A) Hatchling plate worn on anterior vertebrals and costals.

(B) All hatchling plates worn on vertebrals, costals and anterior marginals; growth rings are distinct.

(C) Scutes begin to appear rubbed in their centers with a wearing off of the first few laminae and a vague character about the remaining rings. The nuchal has assumed a single, shallow notch or is flat along the edge.

(D) Slight sinking of scutes, giving the tortoise a "wrinkled" appearance.

(E) Scutes sunk, including along the plastral midline, the midline and carapace seams are deep and wide and the upper layers of the scutes are peeling (or have peeled) off.

> The edges of the anterior marginals are worn smooth, with little or no distinction between each scute edge.

Seven tortoises were short (MCL) for the amount of shell wear they possessed by comparison to tortoises in the California population examined by the author. They included 4 females (200 to 213.5 mm MCL) and 3 males (242 to 259 mm MCL), all of which appeared very old. This may be due to heredity, grazing pressure (i.e. decreased forage) or to a decreased daily activity period over tortoises in colder climes if tortoises are, in fact, diurnal. (Voight, 1975, stated that in three years of observation, no nocturnal or pre-dawn activity was observed.) However, dawn surface temperatures were recorded only in June, when they were already 16.8 to 25.0°C. Tortoises in California were found to start activity when surface temperatures reached ca 17°C. It is possible for tortoises to start activity in pre-sunrise irradiation (Gourley, 1972, stated that anticipation of sunlight occurred ca one hour prior to actual light) and reduce basking due to ambient burrow temperatures above the voluntary minimum (Voight, 1975), both increasing activity periods during hot Nevadan days.

Anomalies. The most prevalent anomalies included curvatures along scute seam lines, especially along the plastral midline (80.9% of all tortoises); pronounced coloration, including extreme darkness either at seam areas or overall (one tortoise exhibited a black plastron) and mottling (66.7%); distinctive shell shapes such as oval, well-flared, rectangular or cylindrical, pear-shaped and laterally compressed (listed in descending order of prevalence, totaling 58.3% of all tortoises); prominent scutes or scute centers (45.2%); misshapen scutes (42.7%); and well-defined diagonal "folds," formed by the corner points of the growth rings and especially prevalent on costal 3(33.3%). In addition, the following anomalies were observed (in descending order of their prevalence): "cracks" (these appearing as straight lines, most often extending laterally from the midline and evident on the bone beneath); extra scutes or irregularities in toenails (e.g. missing, deformed, fused); and extra lumps of scute material or reduced number of scutes.

Injuries. Deep chips or cracks, generally to the bone (20.2% of all tortoises), deep punctures or extreme gnarling (4.8%), predator chewing (aside from those with deep punctures, 3.6%), possible hemorrhaging beneath the scute surface (1.2%), scraped forelegs (1.2%) and an apparent eye injury where the inner lid was dropped (1.2%) were observed within this population.

Growth. Greatest growth rate, expressed as the percentage of MCL change and the percentage of weight change, occurred in the immature age class (the youngest category sampled); in 25 days one tortoise grew 7.1%, a 10.5 mm MCL change, accompanied by an 18.9% (180g) weight change (Table III). Three immature tortoises exhibited no weight change in 18, 27 and 47 days, although the latter 2 of these 3 had MCL changes of 5.8 and 2.5% respectively. Adult males were second in growth rate in both percent weight and % MCL change categories. Interestingly, the one individual which showed a 1.2% MCL change also exhibited an accompanying negative weight change of 3.0%. In the subadult category, 5 females showed no weight change in 23 to 48 days and 3 showed no MCL change in 23 to 48 days. The largest subadult female MCL change, 6.7%, was accompanied by no weight change. It must be kept in mind that the sample sizes are very small.

Eight adult males (207 to 248 mm MCL) and 14 subadult and adult females (180 to 222 mm MCL) measured one ring for every 7 mm in length over 55 mm. (The initial 55 mm was subtracted because 40 to 55 mm is the approximate size of hatchlings.) Twenty-eight immature tortoises (117 to 178 mm MCL) and two Juvenile II's (89 and 99 mm MCL) had one ring per 6 mm MCL over 55 mm. These results are interesting because greatest growth in length per season would be expected of younger tortoises rather than subadults and adults. It is questionable then, if only one growth ring is developed per year.

Behavior

Thermoregulation. Sixty-six active tortoises were found in ambient air temperatures (T_a) of 16.4-35.8°C, temperatures one centimeter from the ground surface (T_{1cm}) of 17.8-33.5°C and ground surface temperatures (T_{gs}) of 21.8-44.4°C. Two active tortoises, one of which was digging a burrow, at T_{1cm} of 41.8°C and T_{gs} of 45.6 and 44.0°C. Lowest T_{gs} for active tortoises were in June, 21.8°C, and May 22.8°C. April lows for activity were 28.8°C. Thirty-four tortoises were found in retreat at T_a's of 18.6-26.3°C T_{1cm} of 21.2-30°C and T_{gs} of 40-44°C. As would be expected, lowest retreat temperatures occurred in April (except for T_{gs}). Retreat occurs primarily in burrows; 82.3% (n = 34) of the tortoises during midday retreat were found in burrows, 100% (n = 4) during April, 66.7% (n = 15) in May and 93.3% (n = 15) in June. At night 84.6% (n = 13) were found in burrows, 100% (n = 1) in April, 71.4% (n = 7) in May and 100% (n = 5) in June. McGinnis and Voight (1971) stated that midday burrow retreats are favored because burrows offer the only sublethal retreat sites on days when ambient temperatures exceed the critical maximum.

Table III. Growth and weight changes expressed as average percent of MCL or initial weight. No changes ≤100 g or 1 mm were considered.

		Sex		
MCL (mm)	Growth	Unk.	♀	♂
101-179	Weight Change	5.8% (0 to 18.9) n = 5 18-47 days	—	—
	MCL Change	4.98% (2.5 to 7.1) n = 4 25-47 days	—	—
180-207	Weight Change	—	0.39% (-3.9 to 6.7). n = 7 5 - 48 days	—
	MCL Change	—	0.08%(0 to 0.3) n = 4 23-48 days	—
>207	Weight Change	—	3.05% (0 to 6.1) n = 2 18-27 days	4.8% (-3 to 19) n = 6 3-56 days
	MCL Change	—	—	1.2% n = 1 56 days

There did not appear to be a change in either midday or evening retreat sites (i.e. burrows or epigean retreats) as the season progressed, although the sample size is probably too small to make any conclusions regarding this behavior. In addition, active burrow lengths and the number of active pallets did not change significantly during the season, averaging between 0.39 (May) and 0.56 (June), with an average of 2.3 pallets per month (n = 48). McGinnis, et al, (1971) noted that burrows are used less frequently as evening retreat sites as seasonable temperatures increase. They stated that tortoises using surface retreats in the evening start foraging at lower body temperatures than those in burrows, resulting in longer foraging time for the epigean-retreat tortoises. It is possible that predator pressure influences nightly retreat locations.

The earliest observed activity was later in the morning in April, 0817 hrs (PST), than in May, 0645, or June, 0515 (Figure 1). (Basking was observed at 0632 in April, however, which might indicate earlier activity than was sighted.) Midday hiatuses occurred in each month, starting later in April (ca 1030-1100) than in May or June (ca 0900 each month) but ending at ca 1630 to 1700 for all months, at which time evening emergence occurred. Although the sample size is small (n = 66) it appears that fewer tortoises were active in the late afternoon and evening than were active in the morning (8 of the 14 tortoises found in retreat during the late afternoon were sequestered at preferred activity temperatures) and the trend was for decreased evening activity (within preferred activity ranges) as seasonal temperatures increased. It is possible that not every tortoise is active daily (Berry, personal communication) as 4 tortoises found in retreat during the morning (0730 to 0825) were there at preferred activity temperatures ((T_{gs}) of 30.3 to 41.9°C).

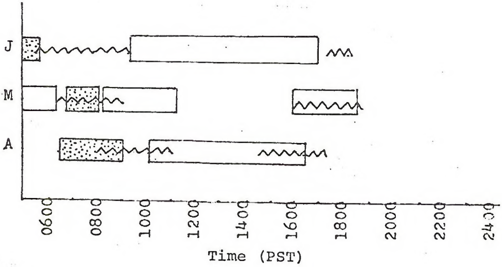


Figure 1. Tortoise activity relative to time of day in June (J), May (M) and April (A). 〰 represent active tortoises, ▨ represent basking and ☐ represent retreat.

Of the 20 active tortoises found in June, 1 was a hatchling, 2 were immatures and the remaining 12 were subadults and adults. Expressed as the percentage of live-tortoises in each age category, the only hatchling was active, 40% of the immatures and 40% of the subadults and adults were active. These young tortoises then, were not more active than adults late in the spring season.

Of the three temperature measurements (T_a, T_{1cm} and T_{gs}), T_{gs} was the most reliable indicator of tortoise activity at wind speeds >6.7 m/sec., during which T_a fluctuated widely (T_{1cm} fluctuated to a lesser extent) -- as T_{gs} remained relatively stable. There was no apparent difference in the effect of wind speed or cloud cover on behavior. All behaviors were noted at wind speeds of ≤ 11.2 m/s and cloud covers $\leq 90\%$.

Movement. Of 27 recaptured tortoises examined for movement, the average observed distance moved was 150 meters and the greatest observed movement was 770 meters, traveled by a subadult female (Table IV). There was no significant difference in distance traveled between either the age classes or the sexes.

Of 47 tortoises, 10.6% (5) were observed to change burrows twice.

Response to handling. In 116 encounters, 47.4% of the tortoises voided. There was a progressive decrease in the percentage of voiding tortoises with size. Females voided more often than males, 50.0% as opposed to 33.3% (Table V). The percentage of body weight voided was consistent for the size classes and the sexes, 1-2.7%, with the exception of two of the juvenile II tortoises who voided 7.1% of their body weight. It must be kept in mind, however, that the sample size for tortoises under 100 mm MCL was very small. Of 25 tortoises encountered more than one time, 60% changed voiding behavior.

Table IV. Average movement. (Values ≤ 80 meters were not recorded; 8 m was the resolution limit of the marking technique employed in the study.)

MCL	Unk.	♀	♂
≤60 mm	—	—	—
61 - 100 mm	—	—	—
101 - 179 mm	140 m (0 - 0.64) n = 9	—	—
180 - 207 mm	—	190 m (0 - 0.77) n = 8	—
>207 mm	—	90 m (0 - 0.32) n = 4	180 m (0 - 0.04) n = 6

Table V. Voiding behavior of tortoises. Volume is percent of body weight.

MCL (mm)	Undetermined Sex	♀	♂	Total % of individuals which voided
≤ 60mm (no ring)	Volume=2.7% n=1	—	—	100% n=1
61-100	Volume=7.1% n=2	—	—	66.7% n=3
101-179	Volume= <1.2% n=19	—	—	52.6% n=38
180-207	—	Volume=<1.6% n=13	—	43.3% n=30
>207	—	Volume=<1.7% n=9	Volume=<1.0% n=9	43.2% n=44
Total % of individuals which voided.	54.8% n=42	50.0% n=44	33.3% n=30	

Insolubilities were voided in 69.2% of 52 urinations. Colors ranged from greyish to white, rose, yellow and one pale green and tan example. Consistency was usually of a curdled nature but was occasionally creamy, grainy or mucilagenous. Urine colors ranged from coffee through amber to yellow. Viscosity was very fluid to viscous.

Three tortoises (2.6%) defecated when handled. Two scat measured 14.5 to 20.6% of the tortoises' carapace length. Composition was primarily fine and medium stems: one scat contained 50% dirt.

Most tortoises assumed a frozen posture or attempted to run down a nearby burrow (four tortoises, all age classes, exhibiting the latter behavior) when they sighted the researcher. They withdrew upon the researcher's approach and/or touch and generally remained in that posture, although some tortoises were active during handling. Immatures and subadults were the most active during handling; 11 (36.7%) immatures were active during handling (6 extremely and 5 slightly) and 7 (38.9%) subadults, all females, were active (3 extremely and 4 slightly). Six (18.8%) adults were active (2 extremely and 4 slightly). There was no apparent sexual difference in the degree of activity exhibited by adult tortoises. The single hatchling captured was very active during handling.

Extreme activity was apparently not related to T_{gs} as only 3 of 11 extremely active tortoises were collected from substrates with a T_{gs} of 44°C. In addition, keeping the tortoise in the shade and separated from the hot ground surface was always a primary concern during handling.

Removal of Tortoises for burrows. Several tortoises were found in burrows. Their behavior there varied from bracing against the burrow ceiling, to avoid removal, to racing out of the burrow after sensing disturbance at the burrow entrance. Often it required only slight activity at the burrow entrance (e.g. measuring) to stimulate a tortoise to exit. The tortoise would back out nearly all the way, turning sideways near the entrance (usually hesitating at this point), and then continue out head first. It was necessary to grab the tortoise quickly at this point as it often slid quickly backward upon sighting the researcher. 3 of 5 tortoises which emerged upon disturbance exhibited re-entrance behavior. All tortoises except juveniles and the hatchling exhibited emergence behavior upon disturbance at the burrow mouth. Perhaps this sensitivity is an intraspecific reaction but it would be counter-productive if the disturbance at the burrow mouth was predator originated.

Touching a burrowed tortoise lightly with a stick often evoked emergence behavior. However, if a tortoise demonstrated anti-removal behavior, extraction required removing enough dirt at the entrance to facilitate obtaining a firm hold on the posterior carapace and pulling rapidly, as soon as the hold was secured. If pulling was not rapid enough, however, the tortoise would stand, pressing his carapace to the ceiling. At this point, depending upon the tortoise's size and the interest in preserving the burrow, the researcher might attempt to put her hands around and in front of the tortoise, collapsing its front legs so that removal could be completed. However, more often than not, the burrow width would not allow this procedure, so the researcher would have to wait with a tenacious grip on the posterior carapace until the tortoise relaxed and then pull rapidly again. Usually, however, the tortoise was by now alerted to being pulled out and would rapidly stand up again. So, extraction could become a rather lengthy waiting process.

Cohabitants. Although no cohabitants of tortoises in burrows were noticed, the possibility of their presence was implied. One adult male tortoise possibly occupied a kit fox burrow, two hatchlings raced into nearby rodent burrows (possibly because they offered the closest refuge from the researcher, but not necessarily because they were the tortoises' normal burrows) and *Neotoma* sp. feces were found in one burrow which was also choked with weeds gathered by the woodrat.

Intraspecific behavior. On one particular patch of desert pavement, several tortoises were often seen within several meters of each other. Here, on 23 April, a subadult female, #18, (198 mm MCL) was being mounted by an adult male, #35, (249 mm MCL) when interrupted by the researcher. A second male, #25, (260 mm MCL) began courting #18 when she walked away from #35 (who had with-drawn when startled by the observer), following her closely and attempting to move in front of her. However, no copulation resulted, #25 leaving #18 despite the fact that she stopped and lowered her plastron to the ground. On 9 May #25 was courting female #44 (227.5 mm MCL).

Further Observations

Sensory Perception. Distance vision in the tortoise appeared to be a primary sensory mode for detecting outside disturbances (e.g. man, other tortoises). It may be possible that olfaction, well developed according to Eglis (1962), is quite influential. In fact, one tortoise in the study site appeared to smell the air, with her head up, facing into the wind and another sniffed my boots and pack extensively. Although Miles (1953) stated that audition is well developed in the desert tortoise, on three occasions tortoises did not detect the author until a separation of only 1.5 m was reached. In at least one of these cases, it was surprising that the tortoise didn't react to the presence of the observer as she was wearing bright reds and blues (able to be detected according to Miles, 1953, Murphy, 1973, and Boynton, 1970).

Eggs. A clutch of 3 whole eggs and one fragment, which was probably tortoise, was found. One was lying in a slight depression in the dirt next to a large, round burrow, probably badger. The other two and the fragment were inside, possibly having rolled there as one egg was cracked. The soil around the entranceway appeared completely undisturbed and subsequent digging by the author revealed no further eggs or undisturbed soil. The texture of the eggs was very smooth, the shell appearing thin and very slightly translucent. (This does not agree with the findings of Grant, 1936 and 1946 and Miller, 1932.) The color was off-white with a faint rosy-orange cast. The shape was nearly round, with a maximum diameter just off center. (This agrees with the findings of Camp, 1916 and 1917, Grant, 1960, and Miller, 1932.) Dimensions were 42 x 31 mm, 44 x 35 mm and 43 x 32 mm (agreeing with Grant, 1936, Camp, 1917 and Burge, 1977a). (See Appendix XV, Miscellaneous Photos for photographs of the eggs.)

Foods. Table VI expressed the foods consumed in 15 observations of feeding tortoises. Although *F. octoflora* was the species observed to be eaten slightly more often, it is apparent that legumes are favored in the diet. In fact, two tortoises consistently walked over *F. octoflora*, *Chaenactis* spp. and several borages, stopping several times to feed only on *Lotus s. brevivexillus* and *Lupinus* sp. Interestingly, L.s. brevivexillus had a low frequency %, 19, and % cover, 0.29, in the analysis of the annual species on the study site (Appendix XIV). Other legumes were less well-represented.

Table VI. Plants eaten in 15 feeding observations.

Species	Part Consumed	Number of Observations	Plant Condition
Festuca octoflora	undetermined	4	dried-3, green-1
Lupinus sp.	undetermined	2	green
Lotus salsuginosus brevivexillus	all above-ground parts	2	green
Erodium cicutarium	undetermined	2-3	green
Lotus tomentellus	leaves	1	green
Lupinus concinnus	leaves	1	green
Malacothrix glabrata	flowers	1	green
Opuntia ramosissima	stem tip	1	green

One and possibly two tortoises, an immature and a large juvenile II, were observed eating dirt. Geophagy was also observed by Sokol (1971).

Burrows. Of 50 fresh burrows examined, there was no significant difference in aperture-facing directions, with ca 3 burrow apertures facing each of 16 directions (e.g. north, north-northeast, northeast, east-northeast, east, etc.). Auffenburg and Weaver (1969) reported that south was the most preferred direction for Arizonan tortoises; however, as the prevailing wind on the study site was from the south, this should have been the least preferred direction in Piute Valley. No tendency for this was apparent, however. It would also seem that east-facing burrows would offer burrowed tortoises the first advantage of solar irradiation, thus providing the occupant with a longer activity period than tortoises which burrowed in burrows of other aperture directions. The results did not support this, however.

Of 44 burrows, the average slope at the entrance was 12.1° (0 - 45°). In 18.2%, the slope decreased slightly or leveled inside. In 36.4% of the 44 burrows, the slope was 0° at the interior terminus.

Burrows were primarily straight, only 10.0% were curving. Of these, 20% curved to the right and 80% to the left.

The average soil cover of 46 burrows at the burrow entrance was 57.8 mm (range: 5 - 350 mm). It was not surprising, then, that several burrows were caved in by cattle.

Few tortoises were found in burrows in which they did not fit snugly. The average burrow width of 43 burrows compared to the associated tortoise's MCL was 112.9% (range: 88.5 - 153.9%).

Burrow placement was primarily at the base of shrubs, which either offered some degree of shade and/or visual protection; 77.4% of 53 fresh burrows were so placed. Of the remaining 22.6%, 13.2% of the burrows were in the open (i.e. not constructed at or near the base of a shrub) but received partial daily shade and 9.4% were completely in the open and 5.7% of the 53 burrows were built into small wash banks.

Vegetation. Sampling of the perennial vegetation according to the point-centered quarter technique, yielding 2,000 samples, showing that Ambrosia dumosa was the plant of greatest importance value and was by far the most dense and frequently encountered species (Table VII). Larrea tridentata, however, was the most dominant plant species and second to A. dumosa, by 45.5%, in importance value. The three species which followed (in descending order of significance) were Krameria parvifolia, Acamptopappus sphaerocephalus and Hilaria rigida (the latter was moderately well represented in the northeastern corner).

Transect to transect variation in absolute density (# plants/ha) was evident as an increase along the eastern border and in the northeastern quarter (Table VIII). The lowest absolute density was reflected in the southwestern

Table V[illegible] Top five perennial species (in IV), av[illegible]e of five transects.*

Species	Relative Dominance	Relative Density	Relative Frequency	IV
A. dumosa	38.4	71.3	54.4	54.7
L. tridentata	55.1	18.1	26.4	24.9
K. parvifolia	2.9	3.6	7.1	4.6
A. sphaerocephalus	0.9	2.3	4.1	2.4
H. rigida	0.1	1.2	2.4	1.2

* IV = Importance Value.

Table VIII. Transect to transect comparison of the absolute densities (#/ha) of the top perennials.

Species	Transect I (NE quarter)	II (SW corner)	III (NW quarter)	IV (E border)	V (SE quarter)
A. dumosa	7414.4	3063.9	4072.4	7868.5	3600.3
L. tridentata	1106.7	445.7	1185.9	1864.9	1770.4
K. parvifolia	306.1	178.3	142.9	51.1	446.3
A. sphaerocephalus	282.5	267.4	57.2	76.6	44.6
H. rigida	188.3	11.1	0	357.7	14.9
Total of all species in transect	9418.9	4456.6	5715.7 6	10218.8	5950.9

corner. Here, ca 25% of the sampling points had to be skipped in order to avoid resampling plants, due to the many vegetally-bare patches of desert pavement. So, the actual absolute density was lower than indicated. The fact that it was as high as it was probably attests to the high density of perennials bordering the patches of desert pavement.

Table IX expresses the monthly change in percent cover and frequency percent of live annuals, showing that there was a significant decrease from April to May. This was not unexpected as I observed that many annuals were going to seed on 23 April (including *Festuca octoflora*, *Lupinus* spp., *Eschscholzia* spp., *Astragalus* spp. and all borages). There were, however, a few which were in their blooming "prime" on this date (*Chaenactis stevioides*, *C. Fremontii*, and *Malacothrix glabrata*) and a few had yet to bloom, including several *Eriogonum* spp., primarily *E. trichopes*, which explains the slight rise in annual percent cover and frequency percent in June as these *Eriogonum* spp. flowered in June. Several perennials, including *Larrea tridentata*, *Acamptopappus sphaerocephalus*, *Eriogonum fasciculatum*, *Ambrosia dumosa* and *Krameria parvifolia* were in full bloom in mid-May.

Substrate. In 500 hits along the perennial transect lines, small rocks (9.4-50 mm in diameter) were hit most

Table IX. Transect to transect and monthly variation of the four major annual species. F% = frequency percent. %C = percent cover.

Transect	I		II		III		IV		V		Average	
Month	%C	F%	%C	F%	%C	F%	%C	F%	%C	F%	%C	F%
April	22.9	90	15.4	53.3	71.5	73.3	19.5	78.3	27.6	75	31.4	74.0
May	0.6	15	0.3	5.0	2.5	25.0	0.4	7.5	4.0	26.7	1.6	15.8
June	2.6	10	3.0	25.0	6.9	35.0	6.5	20.0	1.0	15.0	4.0	21.0
Average	8.7	38.3	6.2	27.8	27.0	44.4	8.8	35.3	10.9	38.9		

often, 36.8%, followed by annual litter, 28.8%, perennial litter, 3.6%, large rocks (> 50 mm in diameter), 2.8%, and Larrea tridentata, 0.2%. There was little transect to transect variation, with slight order changes of the top three substrates occurring in transects I, II and III (Table X).

Table X. Substrate sampling in five transects with 100 hits per transect.

Substrate	Transect I	 II	 III	 VI	 V	Total	%
Small rock	21	50	30	41	42	184	36.8
Annual litter	36	13	31	29	35	144	28.8
Bare ground	39	27	33	21	19	139	27.8
Perennial litter	0	5	4	7	2	18	3[illegible]
Large rock	4	5	2	2	1	14	2.8
L. tridentata	0	0	0	0	1	1	0.2

CONCLUSIONS

1983 okays due to sampling + difficult to find
low intensity

The low percentage of tortoises under 100 mm MCL combined with the unfavorable ratio of adult females to males may indicate that this population has low natality, possibly too low for a healthy population. The high percentage of immature tortoises may indicate that natality was much higher several years prior to this study. Direct (e.g. trampling) and indirect (e.g. forage and cover loss)

Note drought
1970-75
1977 below average ppt
while 1976, 78 + 79 above average
The drought should have precluded recruitment to permanent due to reduced annual forage??

damaged caused by cattle grazing may be responsible for these results. The deleterious effects of grazing have been discussed by Berry (1978). The very reproductively favorable subadult sex ratio may become altered unfavorably as these subadult females reproduce more and are subjected to the stresses of cattle grazing. Mortality is presently within the 5%/year bounds of a healthy population (Berry, 1978). It is crucial that the population parameters of density, size structure and sex ratio and vegetational alterations are studied regularly in order to generate conclusive data regarding significant trends and influences on this population.

ACKNOWLEDGEMENTS

I am extremely grateful to Penelope Crocker and Peter Woodman for their fine field work and all-too-occasional good company. I also thank Mark Maley for his interest in the project, his efficiency and his enthusiastic support. And, my special thanks are extended to Bill Mautner who graciously donated his time to the improvement of my technical writing ability.

Literature Cited

Auffenburg, W. and W. G. Weaver, 1969. Gopherus berlandieri in south-east Texas. Bull. Fla. St. Mus. Biol. Sci., 13: 141-203.

Berry, K. H. 1976. A comparison of size classes and sex ratios in four populations of the desert tortoise. In: Desert Tortoise Council Symposium Proceedings, 1976: 38-50.

--- 1978. Livestock grazing and the desert tortoise. In: Desert Tortoise Council Symposium Proceedings, 1978: 136-155.

Burge, B. L. 1977a. Movements and behavior of the desert tortoise (Gopherus agassizii). Master's thesis, University of Nevada, Las Vegas.

--- 1977b. Aspects of the ecology of the desert tortoise, Gopherus agassizii, at the Ivanpah Valley site, eastern Mojave Desert, San Bernardino County, California. California Desert Program, Bureau of Land Management, Riverside, California. Contr. CA-060-CT-000002. Unpub. Report.

Camp, C. L. 1916. Notes on the local distribution and habits of amphibians and reptiles of southeastern California in the vicinity of the Turtle Mountains. Univ. Calif. Publ. Zool., 12: 503-544.

--- 1917. Egg-laying of Testudo agassizii. Lorquinia, 1(11): 85-86.

Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology, 37: 451-460.

Daubenmire, R. 1959. A canopy coverage method of vegetational analysis. Northwest Science. 33(1): 43-64.

Grant, C. 1936. The southwestern desert tortoise, Gopherus agassizi. Zoologica, 21: 225-229.

--- 1946. Data and field notes on the desert tortoise. Trans. San Diego Soc. Natur. Hist., 10: 399-402.

--- 1960. Differentiation of the southwestern tortoises (genus Gopherus), with notes on their habits. Trans. San Diego Soc. Natur. Hist., 12: 441-448.

Harbison, C. F. 1937. The adobe tick on Gopherus agassizi. Herpetologica, 1: 80.

Hayne, D. W. 1949. Two methods for estimating population from trapping records. Jnl. Mamm. 30(1): 399-408.

Karl, A. E. 1978. An ecological study of the desert tortoise, Gopherus agassizi, at Shadow Valley, San Bernardino County, California. California Desert Plan Program, Bureau of Land Management, Riverside, California. Contr. CA-060-CT8-000042.

--- 1979a. An ecological study of a population of desert tortoises, Gopherus agassizi, in Clark County, Nevada. Bureau of Land Management, Las Vegas, Nevada. Contr. YA-512-CT9-90.

--- 1979b. An ecological study of a population of desert tortoises, Gopherus agassizi, in the western Mojave Desert, California. California Desert Plan Program, Bureau of Land Management, Riverside. Contr. CA-960-CT9-106.

Luckenbach, R. A. 1976. Field estimates of California populations of Gopherus agassizi: I. Procedures. In: Desert Tortoise Council Symposium Proceedings, 1976: 22-29.

McGinnis, S. M. and W. G. Voight. 1971. Thermoregulation in the desert tortoise, Gopherus agassizi. Comp. Biochem. Physiol., 40A: 119-126.

Marten, G. G. 1970. A regression method for mark-recapture estimation of population size with unequal catchability. Ecology, 51(2): 291-295.

Miller, L. H. 1932. Notes on the desert tortoise (Testudo agassizi). Trans. San Diego Soc. Nat. Hist., 7L187-208.

Patterson, R. 1977. Growth and shell relationships in the desert tortoise. In: Desert Tortoise Council Symposium Proceedings, 1977. 158-166.

Peterson, R. 1961. A field guide to western birds. Houghton Mifflin Co., Boston. 366pp.

Schnabel, Z. E. 1938. The estimation of the total fish population of a lake. Am. Math. Mon. 45: 348-352.

Sokol, O. M. 1971. Lithophagy and geophagy in reptiles J. Herpetology. 5: 69-71.

U.S. Department of Agriculture, Soil Conservation Service. Soil classification, a comprehensive system. 7th Approximation, 1960. 265pp.

U.S. Department of Commerce, National Climatic Center. Environmental data and information service. Climatological data national summary, U.P.S. 363 010. 30(4):8. April and May, 1979.

Voight, W. G. 1975. Heating and cooling rates and their effect upon heart rate and subcutaneous temperatures in the desert tortoise (Gopherus agassizii). Comp. Biochem. Physiol. 52 A: 527-531.

Woodbury, A and R. Hardy. 1948. Studies of the desert tortoise, Gopherus agassizii. Ecol. Monogr., 18: 145-200.

Woodman, P. 1979. Ecology of the desert tortoise at the Ivanpah Valley tortoise study site, San Bernardino County, California. California Desert Plan Program, Bureau of Land Management, Riverside, California. Contr. CA-960-CT9-113.

Appendices I-V

I. Locations of live tortoises.

II. Locations of tortoise burrows.

III. Locations of skeletal remains.

IV. Locations of predator sign.

V. Geomorphology and vegetation.

Appendix V- Geomorphology and Vegetation

Appendix I. Locations of live tortoises.

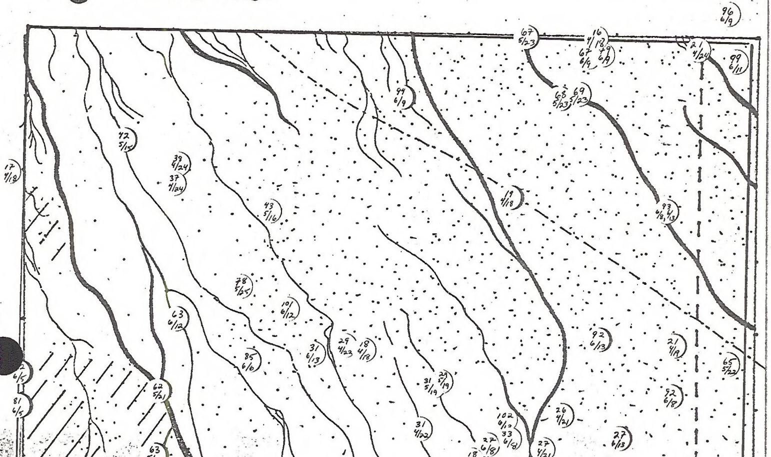
d by width of line, the widest equalling

Dirt road.

▨ = Y. schidigera and desert pavement.

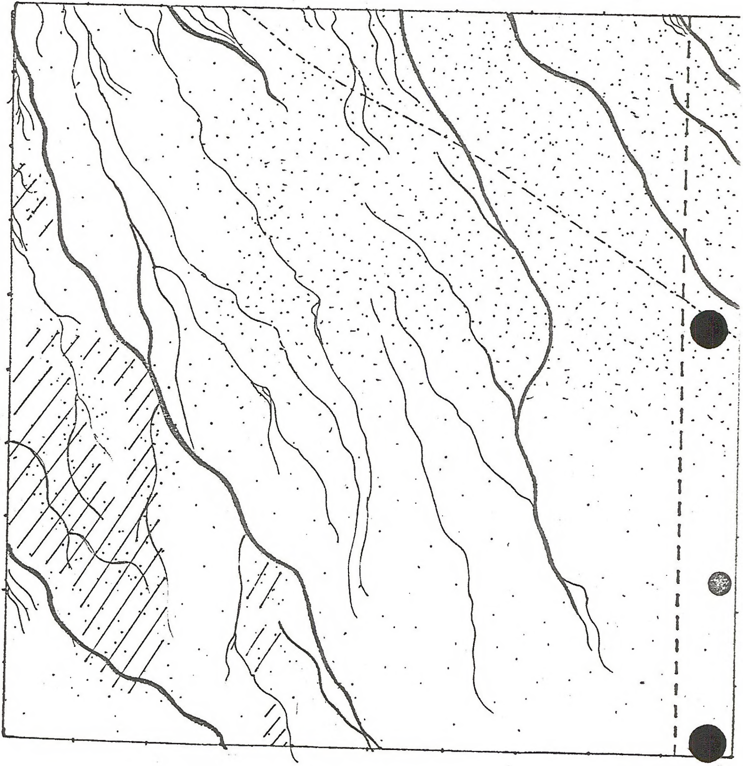
⁘ = Perennial density. Degree is indicated by amount of stippling, the greatest concentration equalling moderately dense vegetation.

● = Watering trough.



Appendix V- Geomorphology and Vegetation

~ = Washes. Size is indicated by width of line, the widest equalling major washes.
-·- = Jeep trail.
- - - = Dirt road.
▨ = Y. schidigera and desert pavement.
⠿ = Perennial density. Degree is indicated by amount of stippling, the greatest concentration equalling moderately dense vegetation.
● = Watering trough.



Appendix V- Geomorphology and Vegetation

Appendix II. Locations of tortoise burrows.

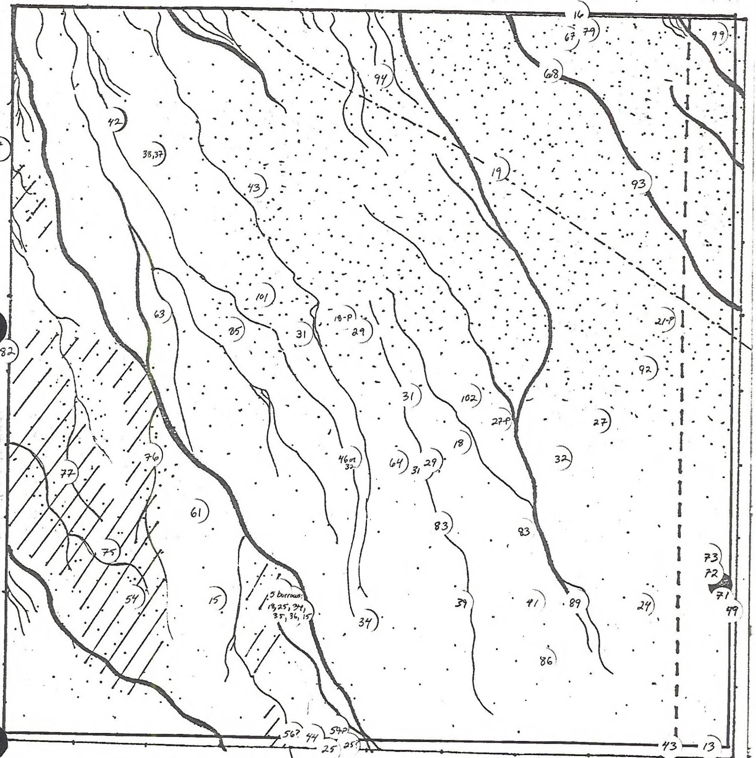
ed by width of line, the widest equalling

= Dirt road.

▨ = Y. schidigera and desert pavement.

⁙ = Perennial density. Degree is indicated by amount of stippling, the greatest concentration equalling moderately dense vegetation.

● = Watering trough.



Appendix V- Geomorphology and Vegetation

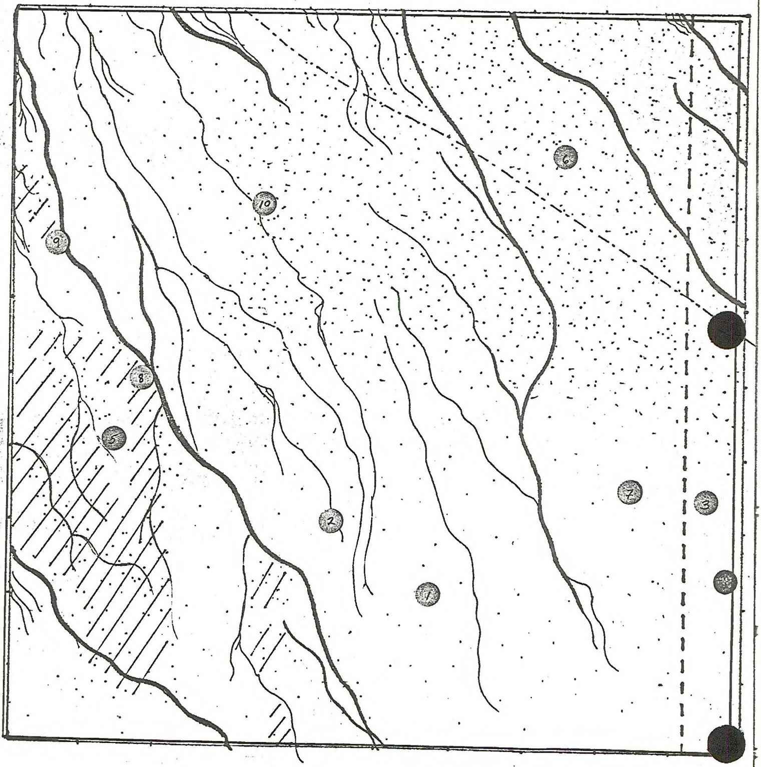
Appendix III. Locations of skeletal remains.

— = Washes. Size is indicated by width of line, the widest equalling

▨ = Y. schidigera and desert pavement.

⁘ = Perennial density. Degree is indicated by amount of stippling, the greatest concentration equalling moderately dense vegetation.

● = Watering trough.



Appendix IV. Predator burrows.

● = Badger

● = Coyote

● = Kit Fox

● Fresh burrow

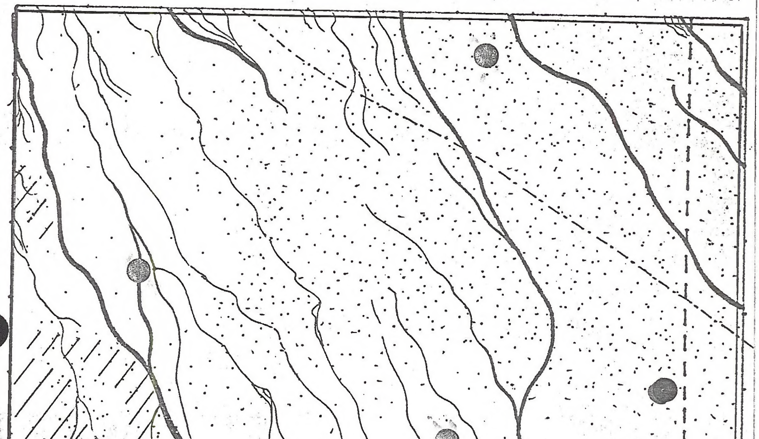
nd Vegetation

ndicated by width of line, the widest equalling

desert pavement.

⁘ = Perennial density. Degree is indicated by amount of stippling, the greatest concentration equalling moderately dense vegetation.

● = Watering trough.



Appendix VI. Standard form for recording live tortoise data.

Appendix VI. Standard form for recording live tortoise data

A. Karl
Piute V.
Spring 1979

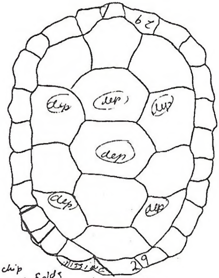
Gopherus agassizi

Site Piute V.
Co. Clark
NW¼ S 34 T 30 S R 63 E
Elev. 2600'

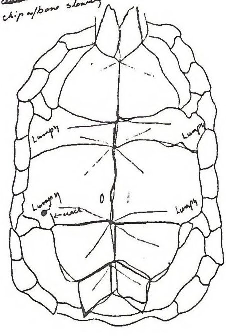
No. 29
Sex ♀
Date 4/22
Time(PST) 0918

°C (shaded) Ta 24.7 (1m); 26.7 (1cm); T_{gs} 36.3
wind/cloud cover SSW 6-7 mph! 2 cirrus, stratocirrus

Behavior Walking ca S, grazing on leaves of Lupinus unk. It is interesting that altho. I saw this tort. from a dist. of ca 10m, he did not see me ⊃
Location 0.57 N 0.55 W



0 = chip
— = ~~crack~~ folds
● = chip w/bone showing



mm
MCL 209
M3(post) 140
M4(mid) 148
7-8(seam) 155.5
Gr W @ 158.5 @ post 7
Ht(mid central-3) 91.5
Pl N 184.5
Pl T 207
Wt(g) 1750 (L)
minus 95 (Pesola)
adjusted ~1650
Photo: Car. 26- #6-6
close-up #20-LC 3+4
other Card #27- #1- LM100 Pygal. #2-P
Gular cond. Fwd. Deep notch. Pointed. Tips slightly incurved
Shell wear own
Injuries None

Anom. Plastron folds well-defined. Plastr. color is very dark around seams.
Parasites None

New growth Plast. midline a little deep altho. no gray area.
Voided ✓
During Ht. meas. mostly insol.
Amount 95 g. (lost ca 1ml urine)
Color Amber
Insol. ✓ Pale greenish + tan. Quite mucilagen.
Finish @ 1000

Note site of epoxied number.

Found a burrow 40m SE of tort. It is fresh & as she had loose dirt on her shell, this is prob. hers. Also she was seen at 1036 heading (poss. coincidentally) in direct. of burrow.

L - 196mm
H - 103
S.C. - 7
W - 187

Faces EENE. No slope (only slight at entranceway due to piled dirt. Freshly uprooted annuals in entrance & dirt at end is very loose so I think this is newly excavated. On E side of a Lycium A. (diam ≈ 0.4m) mound. Full sun until ca 1330, then mottled, reaching full shade at ca 1530.

Behav: cont (altho. I had on a white visor & a lg. blue backpack) until I was ca 1.5m away. Her head was down part of the time, as she was eating, but still she should (I think) have seen me before she did.

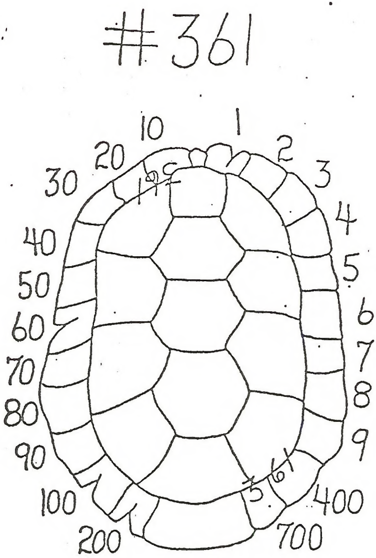
Shell wear P. - Still lumpy in centers of abds & pects. Ca 21 growth rings (a little vague). Not too well rubbed. R abd. has small crack on periphery of post. seam leading to center (ca 1cm long). In center of R abd is a small chip showing bone & peeling. Also a small chip
" " next to midline in R abd.

C. 19-21 growth rings. Some hatchling plate - mostly present in costs. 4, areoles 2-11 & V2 (the latter due to depression in V2), a little in costs 3 & V3. Slightly sunk in V2, V3, costs 2, costs 4 altho this doesn't appear to be an older tort. (one who would have sinking scutes.
Seams are a little deep

Anomalies L gular is shorter than rt. R anal tip curves up.
L hind foot - no toenails altho. there is one bony projection. (Toenails may be worn down completely, but I can't see well)
Centers of V1, costs 1, V4 & pygal are prom.
Slightly flared tort.
1:s LM11 and the ~~ant~~ left portion of the pygal & the post. portion of LM10 are both missing, altho. this appears to be an anomaly not an injury
Ant. L. abd seam - sharp curve near periphery

Appendix VII. Desert Tortoise Council notching system.

Appendix VII. Desert Tortoise Council notching system.



Appendix VIII. Desert Tortoise Shell Data Card.

Appendix VIII. Desert Tortoise Shell Data Card

DESERT TORTOISE SHELL DATA CARD	DATE OF CARD 11/15/79	RECORDER A. Karl	CARD NUMBER 07

DATE FOUND 5/24/79	COLLECTOR A. Karl	SHELL NUMBER 7	SEX ♀	MUSEUM —	MUSEUM NUMBER —

ELEVATION 2560'	GEOMORPHOLOGY Valley	SOIL TEXTURE-PARENT MAT'L coarse sand	OTHER HABITAT USES Grazing (cattle)	VEGETATION Larrea, Ambro.

TOPOGRAPHIC QUAD	NAME Searchlight	COUNTY Clark	STATE Nev.

SCALE 15'	TOWNSHIP 30S	RANGE 63E	SECTION S 34	SUBDIVISION SW¼ (0.17W 0.35N)	SITE NAME Piute V.

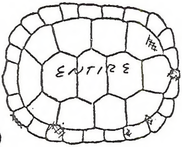
CONDITION OF SKELETON		ENTIRE	✓	LEG BONES		COLOR OF BONE White
AGE OF BONE: SOLID	✓	BROKEN		PELVIS		OTHER
PEELING & CHIPPING		DISJOINING		HEAD		
CRUMBLING		DISJOINTED		VISCERA Intestine	✓	

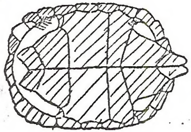
CONDITION OF SCUTES	NONE		POSSIBLE MORTALITY FACTORS	
NORMAL COLOR			UNKNOWN;NO MARKS	
ADHERED TIGHTLY TO BONE			PREDATOR;CHEW MARKS However, the entirety of the	✓
COSTALS AVP VERTEBRALS OFF Gular off		✓	BULLET HOLES shell & the fact that	
OTHER SCUTES LOOSE & PEELING slightly faded		✓	VEHICLE the claw marks are on the	
SCUTE FADED, GROWTH RINGS PEELING			OTHER periphery don't necessarily	
TORTOISE REMAINS IN PREDATOR SCAT			indicate that a predator was	
LIMB OR HEAD PRESENT ONLY			cause of death	

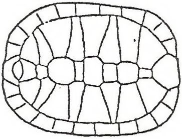
MEASUREMENTS	UNITS	MAX. P.L.	MIN. P.L.	C.L.	3MW (post)	CMW	FLARE OR [✓ 8MW]
	mm	202.5	192	202	136	162	167.5

P: PLASTRON L: LENGTH C: CARAPACE M: MARGINAL W: WIDTH

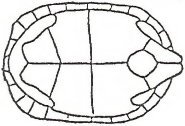
▨ ≡ chewing
✓ ≡ present, not intact
/// ≡ intact







Both are entire.



Appendix IX. Live tortoises.

ting
ite V.
os R63E. S

Live tortoises

Live Tortoises

Tortoise #	Sex	(mm)	PL N (mm)	PL T (mm)	Width m/3 (mm)	MAX. WIDTH / @	Height (mm)	Weight (gms)	Comments
11	Und	131	115	128	94.5	105 / mid 5	61	500 L	Rt. gular slightly longer than left. A very dark tortoise. Rt. anal not as long (dorso-ventrally) as left and is pushed to the right side. Midline seams don't meet at abds. Nuchal is pushed to the right & joins RM1 along entire length. Strong costs. 3 folds. Long outer rear toenails. Costs. 3 depressed. Voided 6 g. amber urine w/pinkish grey insolubilities.
12	Prob ♀	178.5	172	185.5	131.5	145.5 / Post 7	92.5	1330 L	A dark, very richly colored tort. Anals tips much upturned. Anal & pect. seams don't meet at midline. Plas. & post. carapace folds are well-defined (esp. plas. & costs 2 & 3). All scute centers on C. are very prominent, esp V1, V3, V4, V5 & pygal. V3/V4 seam curves up on rt. side. Lm7 more indented than right. Tort. is wide in front & then is nearly cylindrical w/almost no flare.
12	–	–	—	—	—	– / –	—	—	
13	♂	224	207	230	150	183 / mid m8	98	2280 L	Plast. is very richly colored & mottled around the midline betw. the hums. Plastron "folds" & cost. 3 "folds" well defined, those at ant. hums. being very deep. Midline slightly wavy betw. fems. & abd. & pect. seams don't meet. A pear-shaped tort. viewed dorsally. RM7 is narrow. RM6 indented slightly in ant portion. V5 is prom. V3/V4 seam curves. V1 is raised in post. rt. portion & V2 is raised in ant. rt. corner. Both margs. 8&9 are slightly chipped at corners. V3 has 1cm. longitudinal crack.
14	♀	206	160	187.5	149	170.5 / Post m6	95	1890 L	Left rear foot has 2 3RD toenails, both blunted. Left forefoot is missing outer toenail. V3/V4 seam has sharp curve in center. V4 is pushed to rt. V5 upper seam curves inward. Pygal is prom & the area at the upper seams of margs 10&11 is sunken. This tort is squeezed together
						/			on the whole rt. side, compacting Rm 4 5 & 7. The scales on both forelegs (front) are worn off. A well-worn tort. V4 has 2 cracks w/ a depression betw. them extending from L. cost. 3. Gulars are chewed & missing scutes. Pygal & Rm 8&9 are chewed. Poss. eye infections or growths.
15	Und	168.5	144	165.5	108	120.5 / Post m8	78.5	990 L	Voided ca. 10g pale ylw. urine w/pinkish-grey insol. Very cylindrical w/almost no post. flaring. V1 & V4 prom. Costs. 1, 2, 3&4 folds prom. Dark plast. seams. Ant. abd. seams don't meet at midline. Anal midline seam is off-center to the rt. L anal tip is a little chipped. L abd. has a ca 1.5 cm. crack near midline.
16	Und	89	76	84.5	64	71.5 / post m7	46.	71 P	Voided 4g pale ylw. urine. Post. hum. folds well-defined. Vert. ridge slightly evident as curvature of vert. seams. All toenails very long.
17	♀	225.5	194	214.5	154	187 / Post m7	97	2420 L	Voided ca 70g. light orange urine w/pinkish-white insol. Post. pect. & abd. seams don't meet. V4 is prom. Tort. shape is slightly oval but w/a little post. flaring (moreso on rt. side than left). Gulars are extremely short & blunt & the post. of the gulars & ant. of the hums. is chipped away w/bone showing on gulars. L hum. is also chipped on edge here.
18	♀	198	179	197	131	164.5 / mid m8	96	1600 L	Voided 55g amber urine w/ pinkish-white insol. A nearly pear-shaped tort., very narrow in front & wide post. (but w/ only some flaring). L anal slightly longer than rt. Plast. abd. seam wavy. Costs. 2, 3&4 & fem, pect. & abd. folds distinct. The ant. portion of the hums. is depressed. [illegible] indented in ant. portion. Much of C. is depressed for such well-defined growth rings
19	Und	158.5	138.5	157	108	122 / Post 5&7	73	910 L	Voided ~5g amber urine w/ whitish insol. Plastr. folds well-defined. Pect. seams don't quite meet. Richly-colored. A nearly oval tort. w/ almost non-existent flaring of margs 8. L pect. has deep "cut" in center w/ 2 cracks leading to post. seam.
21	Und	172	149	170	113	132 / Post 8	78	1215 L	V1/Nuchal seam wavy. Rt. anal touches left fem., makes plastron midline crooked. Slight peeling & chip.
22	♀	212	191	210	145	171 / Mid 8	97	2375 L	Voided 2ml pale amber urine. Pear-shaped. High ridge around edge of each carapace scute & centers somewhat raised. Narrow nuchal w/ an extra marg. on both sides. Midline not straight. Fairly well-rubbed tort.
23	♂	216	182	215	147	165 / Post 8	97	2075 L	Voided ca 2ml cloudy, yellow urine w/white insol. Midline not straight. Centers of verts 1&4 are peaked. RM5, Lm5&6 have cracks w/ some bone showing.
24	♀	201	173	197	132	157 / mid 8	92	1855 L	Voided 38ml red-brown urine w/ pink, pasty insol. Asymmet. wave in V4/V5 seam. Midline crooked. Moderately-well rubbed. Several chips (one esp. lg. on L gular) show bone.
25	♂	260	227	251	173	200 / Mid 6	111	3565 L	Very mottled, esp. plastron. Midline seams don't meet at fems. RM11 is divided into 2 scutes. Shell is well-rubbed. Several chips show bone - RM2, RM3, RM8, RM9, RM and vent. surface of RM9&10.
26	Und	162	146	162	115	129 / post 7	74	1015 L	Voided 10ml coffee-colored urine w/insol. Seams don't meet on midline. V3/V4 seam curved.
27	♀	193	160	182	120	150 / post 8	85	1505 L	Voided ~15ml lt. brown urine w/insol. Gulars bend sharply rt. as do anals. Left gular tip broken off. Very prom. V4. Moderately rubbed shell w/ gnarled deformed rt. post. shell and several chips showing bone
28	♂	244	222	254	162	184 / post 6	97	2495 L	Midline off-center at ant fems.
29	♀	209	184.5	207	140	158.5 / Post 7	91.5	1750 L	Voided 95g (ml) amber urine w/ pale greenish & tan, mucilagenous insol. Void was 1° insol., not urine. Plastr. folds well-defined. Plastr. color is very dk. around seams. L anal is shorter than rt. & rt. curves up at tip. L. hind foot has no toenails. Centers of V1, V4, pygal & costs 1 prom. No LM11 & post. portion of LM10 & left portion of pygal are missing. Ant. rt. abd. seam has sharp curve near periphery.
31	♂	248	229.5	248.5	(m/4:) 173.5	190 / post 9	100.5	2990 L	Voided ~1ml light amber-orange urine. Extra marg. ant. to marg 5. Plastr. is richly colored w/ numerous sm. dark spots (carap. also spotted). Midline a little wavy. Most plastr. folds [illegible]. Cost. 3 folds well-defined. Upper portion of pygal prom. A long, cylindrical tort. w/ slight post. flaring. Margs 5 indented anteriorly. Nuchal is narrow & joins [illegible] to RM1.

ute V.
10S · R63E S34

Live Tortoises

Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width m/3 (mm)	MAX. WIDTH / @	Height (mm)	Weight (gms)	Comments
27	—	194 194	—	—	—	— / —	 87	1510 1350	
32	Und	117	102	114.5	82	95 / mid 6	59	410 (L)	Excreted 2g. of mostly fine stems and 50% dirt. Only anal seams don't meet on midline. L gular post. seam curves. Plastral folds well-defined. V1 prom. Oval tort w/very slight post. flaring. Plastr. is mod. dark in seam areas + carap. has dark spot in center of each scute.
33	Und (Poss. ♂)	142.5	130	146.5	97.5	110 / post 7	71.5	700 (L)	Voided 9g. mod-dk. amber urine w/pinkish-gray insol. Plast. + cost. 3 folds prom. V1, V2, V3, V4, M5, 4, 6 + costs 1 are prom. in centers. Left forefoot outer toenail curved wrong direction. Cylindrical w/ no post. flaring. Midline a little crooked at anal, ant. pect. seams + betw. pects. Ant. plastr. + carap. has extensive chipping to bone, including chipped off nuchal + R gular scutes
15	—	—	—	—	—	— / —	—	1025 (L)	
25	♂	—	—	—	—	— / —	—	3450 (L) 3660 (L)	Followed #18 as if attempting to court. Did not try.
18		199.5	—	—	—	— / —	—	1580 (L) 1640 (L)	#35 tried to breed her.
34	Und	161	143.5	159.5	112	124 / post 5	78	960 (L)	Voided ~7g pale tan urine w/ whitish insol. Plastr. + carap. richly colored. Ant. pect. seams have sharp curve at periphery. Midline curves ant. to post. abd. seams + pect. + anal seams don't meet at midline. Nuchal/V1, V1/V2 + V2/V3 seams curve in center. Post. carap. folds well-defined. Hairline crack on left abd. post midline.
35	♂	249	208.5	225	172.5	202 / ant.-mid 8	115.5	3270 (L)	Voided 6g pale-ylw, viscous urine w/pinkish-white insol. An old, well worn tort. Ventral surfaces of both hind feet have white, horny patches. Gulars are very short + blunt, curve ventrally + are much off-set to the rt. Midline wavy, ant. abd. seams curve in periphery + post. abd. seams don't meet. Very mottled plastron. Long nuchal. Lower cost seams (esp. R cost. 2) very wavy.
36	Und	145.5	130		97	112 / post 8	70	690 (L)	Voided 8g, milky-ylw urine w/ white, creamy (consistency) insol. Left forefoot has only 4 toenails + the outer 2 are bent backwards together. R. gular post. seam has lg. pale spot. Only anal seams meet at midline. Richly colored plas. + carap. Nuchal curves left. Mod. post. flaring. V1 prom. L marg. 3 a little indented anter. L gular ventral surface has longitudinal line
37	♂	245	216	241	174	201 / post 8	98	3560 (L)	Voided 5ml brn. urine. Plastron gold-colored w/ a few dark splotches. Pect. seam (midline) curves. Worn smooth w/some ring peeling
38	Und.	174	154	172	114	141 / post 8	76	1100 (L)	Voided 7 ml. red-brn. urine. Only anal seams meet at midline. The seam betw. V2 + V3 appears as a fine crack on the left side, normally in the center, non-existent on the rt. V4 prominen
21	—	—	—	—	—	— / —	—	—	
39	Und	143	131	146	(Lm3, Rm4) 100	113 / mid Lm6→Rm7	71	1510 (L)	10 left margs, RM1 reduced. (Assymetry occurs only at ant. end.) Cost. 4's somewhat reduced. V1 prom. Abd. + fem. seams don't meet
41	♀	191	161	188	130	153 / mid 6	94	1500 (L)	Voided 27 ml coffee-colored urine w/ insol. Only anal seams meet on plastron. Costs. 3 + R. cost 4 have strong diag. lines. Conical.
42	♀	183	163	178	123	145 / mid 8	87	1300 (L)	Voided 10ml. brown urine. Ant. abds. + anal seams don't meet at midline. Half of nuchal scute chipped off. Pygal assymetric (rt. of center reduced). Rm11 narrow
43	♀	231	208	224	153	177 / mid 7	100	2370 (L)	Only anal seams meet at midline. Left gular short. Some chipping.
43B	♀	200	180	201	133.5	152.5 / post 5	92	1730 (L)	Voided 40g (Pesola) urine w/mucilaginous insol. All plastr. seams except anals slightly off at midline. Narrow nuchal, slightly compressed on rt. side. Only slight flaring at m8. Richly colored + cost. 3 folds prominent. Some deep chips - RC3, Lm9, R fem., R anal
44	♀	227.5	198.5	226	146.5	181.5 / mid-post 8	101	2890 (L)	Voided 34g urine w/pink insol. Both abds. seams much offset at midline. V3/4 seam curved to left of center. Rm1 divided by "crack". Narrow ant., mod. flared post. Well rubbed + sunk.
45	♀	185	163	184.5	m4 - 124	135.5 / mid 6	90	After 12g void. 1860 (L)	Voided ~10-15mls before weighing, then 3g w/rose insol. Very richly colored. Midline offset betw. anals. Margs. #1 are much reduced esp. RM1 which attaches to the nuchal its entire length. Subsequently, the rest of the margs. are pushed forward. Margs. 8 reduced.
34	Und	172.5				/		1230 (L)	Extensive new growth.
35	♂	[illegible]				/		void. 3880 (L)	Voided ~5mls prior to weighing - included rose-white insol.
41	♀	21[illegible]	181	211	139	160.5 / [illegible]	94.5	1910 (L)	[illegible] dark plastron. All seams exc. ant. pects. are slightly off [illegible] midline. Scute cent [illegible] V1, V2, costs 2 + 3 are raised. Cost. 3 folds prom. Slightly [illegible] w/very sligh[illegible] post. flaring. Deepening seams + mod. rubbed.

le V.

os R63E S3

Live Tortoises

	Tortoise #	Sex	CL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height mm	Weight (g)	Comments
8 /	41	♀	191.5						1680 after 1st void 1610	Voided a couple mls. prior to weighing, including pinkish insol.
/ 8	28	♂							(L) 2785	
/ 8	24	♀							After 1st void (L) 1800	Voided several mls. amber-rose urine w/ rose insol. prior to weighing
8 7	32	♀							2180(L)	(← may = #22. Does not = 32)
3	47	Und	117	100	112	82	93.5 / mid-post 6	58	After 1st void (L) 430	Voided ~5mls urine prior to weighing + ~3mls after. Oval tort. w/ only slight post flaring. Richly colored. Ant. pect. + post. abd. seams slightly offset. Ca 10-12 rings
/ 8	48	Und	165	145	161	116	130 / post 7	78.5	(L) 1020	Voided 9g pink mucilagenous insol. + defecated. 5 ticks. Plastron richly colored + carapace dark. Many carapace seams + midline betw. abds. are wavy. Only 10 margs. each side. Costs. 4 (esp. left) narrowed. V4 reduced. Gulars curve rt. Lump of scute material on ant. rt. corner of V1. Extensive chipping, many to bone. Poss. a ♀, stunted by injuries
8	49	♂	255	230	252.5	173	213 / mid 7	110	After void (L) 3380	Voided ~30g cloudy urine w/ wh. insol. 5 ticks. Mottled plastron. Midline wavy. Pect. seams offset. Narrow V1. V4 + V5 prominent. Ant. margs. upturned. Ver oval, slightly narrow ant. Well rubbed + sunk.
							/			
9 3	31	♂	— 252				/	—	2910(L) 2800(L)	
/	29	♀					/		(L) 1840	
	44	♀					/		(L) 2905	
5	44	♀					/		—	
	51	♂	253	231.5	252.5	176	210 / post. 8	111	(L) 3420	Very dk. plastron. All vert. seams a little curved in center, esp. V3/4. Tort. is narrow ant. w/ good post. flaring. V4 + 5 prominent. Mod. well-rubbed + slightly sunk.
1	52	Und	99	85	93	66.5	77 / mid 6	47	(P) 230	Pect. seams slightly offset at midline. Vertical crack in pygal from ant. edge. Richly colored. V1/2 seam curved. Oval tort. w/ slight post. flaring. V3 + V4 prom. Depressed near midline in hums. Much bubbling under shell.
	53	♂	225	206.5	225.5	158	170 / mid 8	96	(L) 2270	Voided 3g. urine w/ white insol. Very dk. plastron. Mottled. Dark eyes. Midline wavy betw abds. + fems + offset between anals. Oval tort. w/ mod. post. flaring. Post pect. seams don't meet at midline. Mod. worn + wrinkled.
1	54	♀	217	196	218	143	171 / mid 8	99	(L) 2150	Voided a few mls. 8 ticks. Chipped away on ventral gulars, post. Tiny lump of scute material at midline junction of ant. abds. + post. gulars. Well rubbed + smooth w/ slight sinking
	55	Hatch.	63	60.5	63	45.5	52 / mid 6	30.5	(P) 58	Voided 2g. Pect. + abd. seams are offset at midline. Plastr. pale except for very dark seam areas. RM1 wider than LM1 + nuchal is wider on rt. side.

iule V.
30S R63E S34

Live Tortoises

e	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width m3 (mm)	MAX. WIDTH / G	Height mm	Weight	Comments
/ 0	15		177							Extensive (very) new growth.
/ 20	14	♀	206						(2) 1910	
/ 0	43	♀								Arachnid clinging to carapace.
/ 20	36	Und	154						(2) 780	Very extensive new growth
/ 0	56	♀	199.5	171.5	194.5	133.5	154/mid 8	91	(2) 1690	Voided slightly. Very richly colored plastron. Well-defined ant. plastral scute "folds" + cost. 3 "folds". Vert. ridge very prominent as are V1→V4 centers. Straight-sided w/ good post. flaring.
/ 20	57	♀	213.5	199.5	217.5	138	166.5/post.8	94	(2) 1980	Voided ~10ml viscous urine. Only anal seams meet at midline. Midline curves left at post. fems. + is offset betw. anals. Nearly cylindrical tort. All toenails irreg diff. lengths + curvatures, pointing diff. directions. Deep chip on ventral surface of gulars + margs 8+9 chipped to bone (both sides)
/ 7	57	♀							(2) 1970	1 Tick
/ 0	58	♂	242	217	251	170.5	195/post.7	97	(2) 2940	>40 tiny ticks. Very long + upcurved gulars. Midline wavy betw. fems. + all seams except post. abd. are slightly off at midline. V-shape curve on ant. right abd. near periph. Slightly pear-sh., flaring more on rt. side. Third outer toe on left foot is wide + blunt + 4th is very wide, overlapping the third. Rm4+5 indented
/ 20	59	Und	148	128	143	85	112.5/post 8	65	(2) 720	Voided 5mls urine w/ insol. 12 margs. ea. side, added ant. to cost. 2. Rm1 divided into 2 scutes + rt. side of V1 is compressed. Richly colored. Slightly oval w/slight post. flaring.
7	59	Und							(2) 660	
0	61	♂	232	212	233	161	181/mid. 8	105	(2) 2530	1 Tick. Extensive peeling + chips to bone. Plastron richly colored. Midline a little wavy, pect. + abd. seams offset. Both post pect. seams have sharp "V" curves in peripheries, the left into the abd. + the rt. into the pect. w/a crease.
/ 21	61	♂								16 Ticks.
/ 1	62	♂	209	188	216	146	163/post. 8	92	(2) 2000	Voided ~5ml. Plastron midline wavy + most seams don't meet. Post. rt. abd. seam has "v" curve anteriorly
/ 1	63	♀	192	161	185	127	152/post.7	88	(2) 1560	Voided <1ml urine. Gular/hum. + anal/fem. seams don't meet.
/ 1	64	Und.	163	149	167	112	124/post 8	76	(2) 920	Basically unworn. Ant. hum. seams don't meet. Very light plastron.
2	65	♀	[illegible]8	169	186	126	148/mid 8	85	(2) 1340	[illegible]d 24 ml. urine w/ pinkish insol. Post. hum. + post abd. seam[illegible]set at midline. [illegible] center slightly prom.

old V.
30S R63E

Live Tortoises

	Tortoise #	Sex	CL (mm)	PL N (mm)	PL T (mm)	Width m3 (mm)	MAX. WIDTH / G	Height mm	Weight	Comments
2	66	♂	194	179	205	135	155 / post.6	85	(L) 1520	Crack, vertical, in pygal center. Deep chip in L.abd. + in LM4.
3	67	Und	159	145	157	110	123 / post. 7	79	(L) 780	No anom.
	67	Und								
3	68	♀	220	193	218	141	172 / post 7.	95	(L) 2070	Crack from midline into L.abd. Ant. hum. seams don't meet.
	69	♀	180	161	180	124	142 / mid 8.	82	(L) 1240	Crack from midline on R.abd. Prom. V4 + V1. Richly colored.
3	71	♀	191.5	167	187	120	146.5 / mid 8	92	(L) 1500	Fair post. flaring. Dk.green eyes. Post. abds.' midline is wavy + post. abd. seams don't meet. V1, V4 + pygal tip prom; also cost. 3 folds. Lump (small) of scute material in M1 + M3. Deep chipping + peeling along rt. carap. esp. (but on much of carapace). Deep chips on rt. plastron.
3	72	♂	207.5	175	200	137.5	153.5 / post. 8 + post 6	87	(L) 1690	Oval tort. w/ good post. flaring. Left gular broken off + chips in center of end. LM5 reduced + indented deeply in ant. portion. Carapace is dark inbetween whitish (dry-appearing very peely) areas. Plastron is BLACK. Midline wiggly at humerals + betw. abds.
3	73	Und	141	123.5	136	91	106 / mid 8	68	after 1st void (L) 620	Voided ca 5 mls. the 2nd time, several the 1st, w/ insol. Dk. around seams, esp. on carapace. Pygal center, cost. 3 "folds" prom. V1/V2 seam curves sharply forward, V4/5 mildly + V2/3 very gently. Slightly oval tort. on rt. side only w/ more post. flaring on rt. side
	74	♂	213	194	212	149	164 / mid 8	97	(L) 1980	Caked w/ hundreds of tiny ticks on seams + post. margs. Narrow RM8. Carapace dark w/ pale, mottled scute centers. V1/2 seam curves sharply forward. V3+4 very prom V1, centers of costs. 4 slightly. Slight post. flaring on rt. side only. MARGS. 4, RM6, LM7 very indented.
	75	Und	143	126.5	140	94	106.5 / post 5	65	560 (L) after 1st void	Voided <10 ml w/ grayish insol. Richly colored. Post abd. seams don't meet at midline. Slightly oval tort. w/ fair post. flaring.
	76	♂	175	155	172	116	135 / mid 8	82	(L) 1160	20-50 mls. void. Periph. portions of ant. pects. sharply curved. Richly colored. Slightly rectangular w/ mod. post. flaring. Several deep chips ant. carapace
	77	♀	213.5	194	210	137	167 / mid-post 7	96	2130 (L) after 1st void	Voided ca 15 ml. total w/ insol. Gulars very short, curve rt. slightly. Post. pect. seams slightly off at midline. V3/4 seam wavy. Dark carapace. Wide nuchal w/ deep indentation in center. RM8, RM5 + LM6 slightly narrowed
	78	Und.	134.5	118	133.5	87	104 / post 8	63	(L) 480	Voided 1 ml. Richly colored plasts. 1 Tick. Abd. seams don't meet at midline + ant. abd. seams wavy. Straight-sided w/ good post. flaring. Nuchal curves left. V-shaped pygal notch. V3/4 seam curves post. Plastr. + cost. 3 "folds" well defined.
	79	♀	205	186	210	136	166 / mid 7	89	(L) 1730	Tick. Voided ca 15 ml w/ insol. No horiz. plastr. seams meet at midline. V1, V4 centers prom.
	79	-	-	-	-	—	— / —	—	—	
	81	Und.	155	132.5	151	105	120 / post 8	72	(L) 730	Voided ca 2-3 mls. Anals are long w/ upturned tips. Plastr. + cost. 3 "folds" well-defined. Richly colored. Post. abd. seams don't meet at midline. Rt. ant. anal seam curvy. Extra scute betw. V3 + 4. V1 + 4 prom. Slight post. flaring.
	82	♀	205	181	204	132	157.5 / post 8	90.5	(L) 1740	Richly colored. No plastr. seams meet at midline. Cost. 3 folds prom. slightly narrow in front.

V.
R63E S34

Live Tortoises

Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height mm	Weight	Comments
83	Und	147	122	140	LM3 → RM4 100	113.6 / post LM8-RM9	68	(2) 670	Richly colored. Abd., fem. + anal (ant.) folds well-defined. Tiny lump scute material in center of R. fem. Extra rt. marg. fit ant. to M3. LM 4→7 + RM 5→8 are indented horizontally above edge. Abd. seams don't meet at midline. V3/4 seam curves at left of center.
84	Und	139.5	123	137	LM3-RM4 94.5	107 / mid-post LM8-RM9	62	(c) 510	Could be related to #83 judging from xtra. marg. anomaly. Extra rt. marg. ant. to M3 + xtra costal ant. to cost. 2. Richly colored. Narrow nuchal. Cost. 3 "folds", hums., post. pects., post. abds., ant. fems. + ant. anals "folds" well-defined. Ant. portion of V1 recessed.
85	♀	213	187.5	214	141.5	171.5 / mid 8	98	2040	Nuchal is short + deformed. Dk. plastron. Pect + abd. seams don't meet at midline. V1, cost 3 "folds" + post. abd. "folds" well-defined. Seams a little deep w/ some scute sinking. Voided ca 4 mls. A few chips in ant. plastron, 2 to bone.
86	♂	177	158	177	119.5	138 / mid-post 8	77	1080	No seams meet at midline. Richly colored plastron w/ pale spotting on ant. hums. midline. Plastr. "folds" mod. well-defined, also cost. 3 "folds". Good post. flaring. R hum. has dark line from ant. seam.
87	Und	138	114	130	91	101 / post 6	66.5	560	Voided 21 ml. Midline curves to rt. toward post hums. Abd. seams don't meet at midline. Richly colored plastron. Deep puncture ant. R. pygal + RM11. Plastron folds, post. portion of V5 prom. V3/4 seam curves ant. in center. V1/2 seam curves to left of center
88	♀	222	Both meas. are scute → bone, not scute → scute. 185	205	140.5	162 / mid-post 8	97	(2) 1875	Gular scutes gone. Deep chipping post. L. abd. + ant. carapace. Slight post. flaring. Cost. 3 "folds" prom. Very richly-colored plastron. 11 ticks. Extremely extensive new growth.
89	♀	222	195	213	142	171 / post 6	99.5	(2) 2220	Voided ca 3 mls. Rt. gular slightly longer. Midline wavy + abd. seams don't meet. V1 + V4, costs. 2+3 "folds" prom. Mod. post. flaring, indented at 7/8 seam. Ant. costs. sunk.
91	Hatch	55	48	51.5	39	47 / mid 6	28	(P) 37	Voided ca 1 ml w/ insol. 1 nearly-complete ring. Egg tooth very blunt or nonexistent. Pale plastr., only dk. on seams. Pect. seams slightly off at midline.
92	♀?	167	149	164	113.5	128 / post 6	77	890	Deep chips on L cost 3 + LM5+6. Richly colored plastron w/ well-defined folds. Richly colored carapace. No pygal but 2 extra normal-looking scutes instead. Good post. flaring w/ upturning, less on rt. side. Post. pect. seams don't meet.
93	♂	200	178	196.5	136.5	160 / mid-post 8	91	(2) 1700	V3/4, pygal seams curve forward. Post. pect. seam very slightly off at midline. Midline wavy post. to mid abds. V4 center prom. Dark in carap. + plast. seam areas. Nearly cylindrical. Alot of tiny chipping
94	Und	151	135	150	102	117 / post 6	71	(2) 690	Voided ~5 mls. w/ insol. V1→V4 centers prom. Richly colored. All seams slightly off at midline. Lg. anals. Post. carap. folds mod. well-defined. Slightly oval w/ slight post. flaring.
95	♂	255.5	239	263	178	205 / mid 8	115.5	(2) 3280	Several tiny ticks. Midline wavy at post. hums + crooked at abd.-fem. seam. Sharp ant. curves in periph. of ant. pect. seams. Plastr. richly colored w/ slight mottling + well-defined folds. LM 2 - chip out of edge.
96	♀	174	169	176	123	140 / post 7	85	(2) 1100	Slightly chewed RM 3.
97	Und	120	104	115	79	88 / post 8	55	310	
98	♂	215	195	218	152.5	175 / post 8	101	(2) 1950	
99	♂	199	180	198	142	158 / mid 6	88	(c) 1525	3 ticks. Deep seams.
101	♂	[illegible]	240	263	186	199 / post 8	113	(2) 3400	[illegible]ded. 11 ticks.

ute V.

30S R63E S3

Live Tortoises

e	Tortoise #	Sex	CL (mm)	PL N (mm)	PL T (mm)	Width m3 (mm)	MAX. WIDTH / G	Height mm	Weigh	Comments
'3	102	♂	217	187	220	157	194 / mid 7	113	(L) 2650	1 Tick. 12 margs. both sides. A very short, high tortoise.
0	57									
'0	77									
2	63									
3	92									
3	93									

Appendix X. Tortoise shells.

ute V.
05 R63S S34

Shells

Shells

te	Shell #	Sex	MCL (mm)	MAX. P.L. (mm)	MIN. P.L. (mm)	Width m3 (mm)	Width in 6 (mm)	MAX. WIDTH (mm) / @	Comments
/17	01	♀	U	175	187	U	U	U /	Right side up w/ this year's growth around shell
/19	02	♀	194.5	186.5	173	137.5	154	154 / 8m	
/23	03	♂	~subad	U	U	U	U	U /	
/20	04	U	U	89	83	U	U	U /	
/21	05	♂	255	262	248	179	203	213 / 8m	Bullet holes
/23	06	U	Adult	U	U	U	U	U /	
/24	07	♀	202	202.5	192	136	162	167.5 / 8m	Pred. claw marks.
/5	08	♂	U	214	196	155	U	U /	
/6	09	prob. ♂	lg. adult	U	U	U	U	U /	
/12	10	U	Adult	U	U	U	U	U /	
								/	
								/	
								/	
								/	
								/	
								/	
								/	
								/	
								/	

U= Undetermined

Appendix XI. Tortoise burrows.

Piute V.
T30S R63E S34

Burrows and Pallets

Burrows and Fallets

te	Asso. w which tort.	Pallet or Burrow	Length (mm)	Width (mm)	Height (mm)	Soil Cover (mm)	Aper Direction	Slope	Veg. Description	Comments
/ 17	13	B	441	207	117	45	WNW	Level inside; ca 15° at entrance	Situ, in the center of a Larrea clone (tot. diam. ≃1.6m) w/one stem at the NW corner of entr., one ca 10cm. SSW + one ca 0.5m ESE. (Each has a ca 0.5m diam.). Receives mottled shade all day	Curves slightly to the right.
/ 18	17	P	0/240	~230	Height + S.C. 80		S	0	In a clone of 4 Ambrosia (tot. diam ≃0.6m), the stems of 2 of them forming the sides. Total shade all day except at ca 12-1400, when it receives mottled shade.	
/ 8	18	P	94/220	234	92	24	E, altho. entranceway curves to eventually face S.E.	Entranceway is ca 15°, level inside.	Under a Lycium A. (diam. ≃ 0.6m) whose stem forms north side of entranceway + whose branches overhang most of entranceway + pallet (all of latter). Full shade all day	
/ 8	19	B	381	174	97	35	NNE	Ca 10°, level at very end.	Located at w. side of E. bush in an open Larrea clone. (Diam. of near bush is ca 1m) this offers full shade until ca 0900, when shade is mottled until ca 1300, when there is full sun. Mottled shade again (from rest of clone) from 1600 → (full late P.M.).	
9	21	P	200	115	—	—	W	0	Under a Larrea, 1m diam.	Curves to left at 11
0	24	B	1100	200	120	350		Steep, ca 50%	0.5m from entr. (N.) is Larrea clone (0.75m diam.) which offers no shade to entr. at all. 0.5m S is Ambrosia (0.25m diam), offering no shade	Curves to left at 1110mm. This looks like some other spore excavation, used by tort. for the night.
/ 20	25	B	300	260	130	50	W	ca 20%	Betw. 1330 + sundown, sun shines in borrow. Larrea clone (0.75m diam) 0.75m S.W. offers mottled P.M. shade. Another Larrea clone (0.5m diam.). 0.2m E gives mottled A.M. shade	Burrow seems to continue after 300mm but is much more narrow + lower
/ 21	27	P	100	250	130	250		ca 2%	E of Larrea clone (diam. ≃2m), underneath plants on stream bottom (west bank of stream). Shade all day	
22	29	B	190	187	103	7	EENE	0	On E. side of Lycium A. (diam. ≃ 0.4m) mound. Full sun until ca 1330, then mottled, reaching full shade at ca 1530	Prob. newly excavated burrow. Is poss. (prob) #29's burrow.
2 (w.)	31	B	732	248	128	115	SW	Entr. is mod. ca 30-35° - level inside	At NE end of Larrea clone (diam ≥2.8m). Mottled shade all day	Curves to left.
24	37, 38	B	600	270	150	170	SE	ca 15% at entr., almost level inside	Ambrosia 0.3m N (diam. ≃0.5m); Larrea (diam.≃ 1m) 0.7m N. Offer no shade	Length for tort. 37 would be more like 1000mm.
5	39	B	120	150	80	20	ENE	20% at entr., level inside	Larrea (diam. ≥ 1m) 0.1m west, mottled shade from ca 1100 to sundown. Early A.M. shade from Festuca octoflora	
-	42	B	600	220	100	10	NE	~20%	0.3m E is Ambrosia (0.1m diam.), 0.7m N is Larrea clone (1m diam) shade only in early A.M.	
,	43	B	700	270	120	20	W	~15° until very end, then level.	Entrance shaded early A.M. only by Opuntia echinocarpa 0.2m E. (diam. ≃ 0.3m), Larrea 0.1m ESE (diam ≃0.1m) and Larrea 0.2m ENE (diam ≃0.2m)	
/ 17	43B	B	~203	232-215	94-120	70-59	2 entrances - NNE + SW, the former fresh.	20°	Betw. 2 Larreas (0.8 diam. ea.) which offer scantily mottled shade early A.M. + late P.M.	
/ 18	34	B	559	175	87	90	SSE	~15°, prob levels at end.	In open. 0.8m from nearest shrub.	
8	46	B	642	225	115	27	WSW	10°	Larrea (0.4m diam.) at SE corner providing slightly mottled shad to ca 1330	may belong to #32 or to both torts.

Piute V. T30S R63E S34

Burrows and Pallets

	Assoc. w/ which tort.	Pallet or Burrow	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	Soil Cover (mm)	APERTURE DIRECTION	Slope	VEGETATION	COMMENTS
/18	41	B	425	219	129	38	E	10°, level at end.	Betw. 2 Larrea (0.5m diam. each) which offer mottled shade from ca 1030-1400.	
/19	31	B	~340	255	128	40	W	5°.	In Larrea clone (~0.2m diam) but only mottled shade (slight) in late P.M.	
/19	29	B	380	223	117	27	NW	15°	At NW base of Larrea clone (0.8m diam.) Well-mottled shade in A.M.	
/19	18	B	~240	213	96	5	N	5°	At base of Larrea (0.5m diam.) offering mottled shade after ca 0900.	
/19	54	B	190	240	118	30	N	5°	In a Larrea clone (≃3m diam.) offering mottled shade all day (least at 1300)	
/19	55	B								A rodent hole (lg.), 2x as tall but same width as tort.
/20	25.	B	580	230	120	80	WSW	~5°	Small Ambrosia (~0.3m diam.) nearby but basically in open.	Poss. belonging to this tort., both fresh. Also, #25 was found at the second
"	"	"	100 (70 tort.)	312	159	59	ENE	~35°, level at end.	Larrea clone (~1m diam.) 0.5m ENE offering mottled shade early A.M.	burrow later in the A.M.
/20	56	B	274	220	100	90	WNW	5-10°	Under a Krameria (1m diam.) at wash edge on top of bank. Full shade.	Poss. for this tort. Angles left.
/20	58	P	~260	~310	~70		~SE	0	A depression at base of Larrea clone (1.2 x 0.5m). Mottled to good shade from 1100 on.	
	59	B	232	183	104	72		5°	In W. bank of wash, 0.4m up bank & well concealed by Acacia & Salazaria. Total shade.	Rodent hole at burrow's end. Poss. belongs to this tort.
1	61	P	(L_1 = 40) 370	200	90	40	W	0	Larrea clone (1m diam.) 0.3m south providing scant shade 0800-1600.	A depression in the ground ±.
/21	64	B	650	230	156	140	E	~5°, levels inside	1m ESE of Larrea (1m diam.) Very light shade before 0730. 2.5m of Ambrosia	Not frequently used, entr. choked w/weeds. Neotoma feces.
9	67	B	~930	184	82	67	W	~15°	In Larrea clone (1.2m diam.) mottled shade 0600-1100	
3	68	B	360	240	120	30	NE	ca 35° levels inside	Sparse to mottled shade all day. Ambro. (0.2m) 0.3m E.; Larrea (0.5m) 0.3m SE; Larrea (0.6m) 0.4m SW; Larrea (0.4m) 0.1m N.	
3	71	B	251	229	104	16	SW	10°, level at end	On S.W. side of Larrea (1.2m diam.) offering early A.M. shade, then mottled to ca 1200. Full sun >1200 hrs.	Another burrow of ca same size lies 1.5m W, but not recently used.
3	73	B	455	217	110	43	S	10° slope, level at end	0.2m south (& in mound of) of nearest stem of open Larrea clone (2m diam.) offering no shade	
1	75	B	164	157	93	27	E	~5°	On NE side of Larrea clone (1x 2.5m) which offers mottled shade in late P.M. only	
4	76	B	380	191	93	22	E	5°	In E side of Larrea mound (~0.8 m. diam.) & 0.6m NNE of Larrea clone (0.5m diam.). Poss very slight shade late P.M. only.	
1	77	B	315	230	98	110	S	20°, level at end	Larrea (0.8m diam.) 0.3m NW. offers slightly mottled shade late P.M. only.	
-	44	[illegible]	718	98	143	67	E	5-[illegible]	No cover. Sm. Ambrosia (0.2m diam.) 0.2m N.W.	

Piute V. T30S R63E S34 Burrows and pallets

TE	Assoc. w/ which Tort.	[illegible]	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	Soil Cover (mm)	APERTURE DIRECTION	[illegible]	VEGETATION	COMMENTS
/9	79	B	715	215	100	16	NW	~25°, lessens inside	At NW side of Larrea clone (2.1m diam.) offering good shade until 0800 mottled to 1330	
/5	82	B	411	259	109	8	WSW	5-10°	At WSW side of Larrea clone (1.5m diam.) + partially overhung by branches. Receives total very early A.M. shade	→ , then mottled to ca 0900, then full sun and mottled shade betw. ca. 1300 + 1400
/5	83	B	~335 (but burrow caved in slightly)	158	102	49 (see length)	WSW	5°	On W. side of Larrea mound (~1m diam.), the shrub offering slight early A.M. shade.	
/6	85	B	680	244	146	34	W	10°, level at end	On W. side of Larrea mound (2m diam.) which offers very early A.M. shade only, slight to ca 0800.	Recent but not nec. fresh (substrate is loose rock.
/6	86	B	416	198	86	31		~10°	On N. side of Larrea (0.9m diam.) + a sm. Ambro. (0.2m diam.) is at NE corner of burrow. Mottled shade	→ in early A.M. + slight mottling off + on throughout the day.
/7	32	B	392	156	79	19	SSSE	5°	At SE corner of Larrea clone (1.2m diam.), which offers slightly mottled shade all day.	
/7	89	B	435	273	132	49	ENE	5°	At NE edge of Larrea, Ambro. gp. (~1.5m diam.) offering slightly mottled P.M. shade.	
/8	92	B	290	173	85	32	NNE	5°	Ambro. (0.3m diam.) at E. corner + one (0.3m diam.) 0.2m S.W. Also Larrea clone 0.6m WSW (1.1m diam). Complete	→ to well-mottled shade to ca 1200 + mottled late P.M. shade.
/8	93	B	1350	246	130	54	NW	~15°, lessens inside.	Sm. Larrea clone, open, 0.6m diam., 0.3m S.E.; Ambro. (0.2m diam.) at W. corner. Mottled shade to mid-	→ A.M., good late P.M. shade.
/9	94	B	437	172	84	26	WSW	5°, level at end	On W. side of open Larrea clone (2m diam.), good shade to 0830, mottled to ~1300.	
/9	95	B	415	290	133	96	S	0-5°	On N. side of ESE-WNW wash, ~0.6m up gentle bank. Under a Larrea clone (2m diam) + 0.6m	→ ENE of Ambro.-Krameria clump (0.6m diam.) Well-mottled shade entire day.
/3	27	B.	780	190	105	40	S		1m. diam Larrea clone	
/3	31									→ Poss. using kit fox burrow.
3	18, 25, 35, 36, 15, 34 ?	P	72/270	285	71	49	W	—	At N. side of Larrea clone stem (1.5m diam). Mottled shade all day.	Next to wash but not in bank.
'	"	B	350	299	151	118	ESE	15°, levels at end	On E side (but in) Larrea clone (~2m diam). Mottled shade most of day except sun at 1000-1330	Next to wash but not in bank
	"	B	159	205	~99	~45	W	15° at entr., level inside	Mottled shade after 1600 from Larrea clone 0.6m W	Prob. #34's or 15's. At top of gradual wash bank
	"	B	160	238	105	64	SW	0	Well-hidden in lg. Ambrosia (~1m diam). Full shade before 1200, mottled after.	In E bank (small) of wash
	"	B	300	212	95	65	NNW	0	In N. side of Larrea mound but no stems w/in 0.8m. Mottled shade befor 0900, then full sun.	

Appendix XII. Vegetation of the study site.

Appendix VII. Vegetation of the study site, annuals (a), perennials (p) and biennials (b).

Agavaceae

- *Yucca schidigera* (p)

Boraginaceae

- *Amsinckia tessellata* (a)
- *Cryptantha augustifolia* (a)
- *C. circumcissa* (a)
- *C. micrantha* (a)
- *C. nevadensis* (a)
- *C. pterocarya* (a)
- *Pectocarya penicillata* (a)
- *P. platycarpa* (a)
- *P. recurvata* (a)
- *Plagiobothrys arizonicus* (a)

Cactaceae

- *Echinocactus acanthodes* (p)
- *E. polycephalus* (p)
- *Mammillaria microcarpa* (p)
- *Opuntia basilaris* (p)
- *O. echinocarpa* (p)
- *O. Parishii* (p)
- *O. ramosissima* (p)

Campanulaceae

- *Nemacladus rubescens* (a)

Compositae

- *Acamptopappus sphaerocephalus* (p)
- *Ambrosia dumosa* (p)
- *A. eriocentra* (p)
- *Baileya multiradiata* (b, p)
- *B. pleniradiata* (a, p)
- *Calycoseris Parryi* (a)
- *Chaenactis carphoclina* (a)
- *C. Fremontii* (a)
- *C. stevioides* (a)
- *Encelia virginensis* (p)
- *Eriophyllum lanosum* (a)
- *E. Pringlei* (a)
- *E. Wallacei* (a)
- *Haplopappus Gooddingii* (a)
- *Machaeranthera tortifolia* (p)
- *Malacothrix Coulteri* (a)
- *M. glabrata* (a)
- *Pectis papposa* (a)

Appendix XII, continued

Compositae (continued)

- *Porophyllum gracile* (p)
- *Psilotrophe Cooperi* (p)
- *Rafinesquia neomexicana* (a)

Cruciferae

- *Lesquerella Palmeri* (a)
- *Lepidium lasiocarpum* (a)

Cucurbitaceae

- *Cucurbita palmata* (a)

Cuscutaceae

- *Cuscuta* sp. (parasitie)

Euphorbiaceae

- *Euphorbia polycarpa* (p)

Geraniaceae

- *Erodium cicutarium* (a)

Gramineae

- *Festuca octoflora* (a)
- *Hilaria rigida* (p)
- *Muhlenbergia Porteri* (p)
- *Stipa speciosa* (p)

Hydrophyllaceae

- *Phacelia crenulata* (a)

Krameriaceae

- *Krameria parvifolia* (p)

Labiatae

- *Salazaria mexicana* (p)

Leguminosae

- *Acacia Greggii* (p)
- *Astragalus acutirostris* (a)
- *A. didymocarpus* (a)
- *A. Layneae* (p)
- *A. lentiginosus* (p)
- *Lotus salsuginosus brevivexillus* (a)
- *L. tomentellus* (a)
- *Lupinus concinnus* (a)

Malvaceae

- *Sphaeralcea ambigua* (p)

Onagraceae

- *Oenothera Boothii condensata* (a)

Appendix XII, continued

Papaveraceae

Eschscholzia glyptosperma (a)

E. minutiflora (a)

Plantaginaceae

Plantago insularis (a)

Polemoniaceae

Eriastrum diffusum (a)

Langloisia setosissima (a)

Linanthus aureus (a)

L. dichotomus (a)

Polygonaceae

Chorizanthe brevicornu (a)

C. rigida (a)

Eriogonum angulosum (a)

E. fasciculatum (p)

E. nidularium (a)

E. trichopes (a)

Ranunculaceae

Delphinium Parishii (p)

Solanaceae

Lycium Andersonii (p)

L. Cooperi (p)

Zygophyllaceae

Larrea tridentata (p)

Appendix XIII. Perennial vegetational analysis.

Appendix XIII. Perennial vegetational analysis, average of five transects.

Species	De*	RDe	Dom	RDom	F	RF	IV
Ambrosia dumosa	5204.5	71.2	1575.5	38.4	0.96	54.4	54.7
Larrea tridentata	1274.7	18.1	1230.9	55.1	0.47	26.4	24.9
Krameria parvifolia	224.9	3.6	63.4	2.9	0.13	7.1	4.6
Acamptopappus sphaerocephalus	145.7	2.3	19.8	0.9	0.07	4.1	2.4
Hilaria rigida	114.4	1.2	1.6	0.1	0.04	2.4	1.2
Eriogonum fasciculatum	35.1	0.7	3.7	0.2	0.02	1.2	0.7
Opuntia ramosissima	27.4	0.6	4.7	0.3	0.02	1.0	0.7
Ephedra nevadensis	14.1	0.2	0.2	0.004	0.002	0.1	0.6
Euphorbia albomarginata	52.8	0.9	0.2	0.01	0.02	0.9	0.6
Eriogonum inflatum	2.9	0.1	0.2	0.01	0.002	0.1	0.6
Yucca schidigera	6.7	0.2	15.1	1.1	0.01	0.3	0.5
Sphaeralcea ambigua	20.5	0.5	0.6	0.04	0.02	0.8	0.4
Lycium Andersonii	7.3	0.2	8.1	0.5	0.01	0.3	0.3
Porophyllum gracile	6.7	0.02	0.8	0.1	0.004	0.2	0.1
Opuntia echinocarpa	5.1	0.1	0.3	0.02	0.004	0.2	0.1
Salazaria mexicana	2.9	0.1	5.1	0.2	0.002	0.1	0.1
Lycium Cooperi	4.7	0.1	3.2	0.04	0.002	0.2	0.1
Erioneuron pulchellum	2.2	0.1	0.004	0.0004	0.002	0.1	0.1

*De = absolute density (#plants/ha); RDe = relative density; Dom = dominance (m^2/ha); RDom = relative dominance; F = frequency; RF = relative frequency; IV = importance value (RDe + RDom + RF)

Appendix XIV. Annuals' vegetational analysis.

Appendix XIV. Annuals' vegetational analysis.

Species	% Cover		Frequency %	
	April only	All months	April only	All months
Festuca octoflora	21.2	7.30	94	38.7
Chaenactis spp. (*Fremontii* and *stevioides*)	6.5	2.30	77	31.0
*Eriogonum trichopes**	4.5	1.50	26	8.7
Erodium cicutarium	3.5	1.42	29	13.7
Chaenactis carphoclina	2.5	0.88	15	7.3
Pectocarya spp. (*platycarpa* and *recurvata*)	2.1	0.70	52	17.3
Malacothrix glabrata	1.6	0.57	19	7.3
Amsinckia tessellata	1.5	0.50	30	10.3
Lotus salsuginosus brevivexillus	0.9	0.29	19	6.3
Eriophyllum lanosum	0.7	0.23	23	7.7
Lepidium lasiocarpum	0.6	0.22	19	6.7
Lupinus concinnus	0.63	0.22	1	0.3
Lotus sp.	0.40	0.14	2	1.0
Astragalus didymocarpus	0.38	0.13	5	1.7
Pectocarya penicillata	0.33	0.11	8	2.7
Eriogonum sp.	0.33	0.12	8	0.3
Unknown composite	0.23	0.08	4	1.3
Cryptantha pterocarya	0.18	0.06	7	2.3
Oenothera Boothii condensata	0.18	0.06	2	0.7
Chorizanthe brevicornu	0.15	0.08	6	3.3
Cryptantha micrantha	0.13	0.13	5	4.0
Small unknown *Cryptantha* spp.	0.13	0.04	5	1.7
Astragalus acutirostris	0.13	0.04	2	1.7
Cryptantha augustifolia	0.10	0.03	3	1.3
Linanthus dichotomus	0.08	0.03	5	2.0
Plantago insularis	0.08	0.03	3	1.0
Eriophyllum Pringlei	0.08	0.03	3	1.0
E. Wallacei	0.05	0.03	2	1.0
Cryptantha nevadensis	0.05	0.02	2	1.0

Appendix XIV, continued.

Chorizanthe rigida	0.05	0.02	2	0.7
Nemacladus rubescens	0.05	0.02	2	0.7
Tiny unknown Eriogonum spp.	0.05	0.02	2	0.7
Linanthus aureus	0.05	0.02	2	0.7
Eriogonum angulosum	0.03	0.03	2	1.3
Cryptantha circumsissa	0.03	0.01	1	0.3
Lesquerella Palmeri	0.03	0.01	1	0.3
Eschscholzia glyptosperma	0.03	0.01	1	0.3
E. minutiflora	0.03	0.01	1	0.3
Calycoseris Parryi	0.03	0.01	1	0.3
Tiny unknowns.	0.03	0.01	1	0.3
Unknown Astragalus sp.	0.03	0.01	1	0.3
Eriastrum diffusum	0.00	0.01	—	0.3

* The figures for this species are for June only in the first column and for all months in the second column

DATE DUE
GAYLORD
PRINTED IN U.S.A.

BLM LIBRARY
SC-324A, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047